U.S. DEPARTMENT OF THE INTERIOR

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THE GEORGES BANK MONITORING PROGRAM:

ANALYSIS OF TRACE METALS

IN BOTTOM SEDIMENTS DURING THE THIRD YEAR

OF MONITORING

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Final report submitted to the
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ABSTRACT

Of the 12 elements analyzed in bulk (undifferentiated) sediments collected adjacent to drilling rigs on Georges Bank, only barium was found to increase in concentration during the period when eight exploratory wells were drilled on Georges Bank (July 1981 until September 1982). The maximum postdrilling concentration of barium (a major element in drilling mud) reached 172 ppm in bulk sediments near the drill site in block 410. This concentration is higher than the predrilling concentration at this location by a factor of 5.9. This maximum barium concentration is within the range of predrilling concentrations (28-300 pm) measured in various sediment types from the regional stations of this program. No drilling-related changes in the concentrations of the 11 other metals have been observed in bulk sediments at any of the locations sampled in this program.

We estimate that about 25 percent of the barite discharged at block 312 was present in the sediments within 6 km of the rig, four weeks after drilling was completed at this location (drilling period: December 8, 1981-June 27, 1982). For almost a year following completion of this well, the inventory of

barite decreased rapidly, with a half-life of 0.34 years. During the next year, the inventory decreased at a slower rate (half-life of 3.4 years). The faster rate probably reflects resuspension and sediment transport of barite-rich material residing at the sediment surface. Elevated Ba concentrations in postdrilling sediment-trap samples from block 312 indicate that such resuspension can occur up to at least 25 m above the sea floor. As the remaining barite particles are reworked deeper into the sediments by currents and bioturbation, removal by sediment transport processes is slower.

The barite discharged during the exploratory phase of drilling is associated with the fine fraction of sediment and widely distributed around the bank. We found evidence for Ba transport to Great South Channel, 115 km west of the drilling, and to stations 2 and 3, 35 km east of the easternmost drilling site. Small increases in Ba concentrations, present in the fine fraction of sediment only, were also measured at the heads of both Lydonia and Oceanographer Canyons located 8 and 39 km, respectively, seaward of the nearest exploratory well.

INTRODUCTION

This study was designed to establish the concentrations of trace metals in sediments prior to drilling on Georges Bank and to monitor the changes in concentrations that could be attributed to petroleum-exploration activities. Some of the specific questions addressed were (1) Where do discharged drilling muds accumulate on Georges Bank; (2) How much do trace metals increase as a result of accumulating drilling mud; and (3) In areas where drilling-mud components increase, how long do they remain at an elevated concentration after the drilling is completed?

This U.S. Geological Survey (USGS) study supports the main thrust of the Georges Bank Monitoring Program, that is, to evaluate potential adverse effects of drilling effluents on bottom-dwelling organisms. The other studies (and contractors) within the Georges Bank Monitoring Program include (1) the analysis of benthic infauna (Battelle New England Laboratories and the Woods Hole Oceanographic Institution), (2) the analysis of hydrocarbons in bottom sediments and the analysis of hydrocarbons and trace metals in benthic fauna (Scientific Applications, Inc.), and (3) the analysis of previous benthic infauna samples from Georges Bank (Taxon, Inc., Michael and others, 1983). The concentrations of trace metals and hydrocarbons in commercially important species of fish and shellfish on Georges Bank have been determined in ongoing programs conducted by the National Oceanic and Atmospheric Administration (Cooper and others, 1981; Cooper and others, 1983). This report is based on data generated by the USGS during all three years of the program. Only the data generated in the third year is tabulated in this report. Tabulation and interpretation of data obtained during year one and year two are contained in final reports for each year (Bothner and others, 1982, 1983).

The first cruise of the monitoring program occurred just before exploratory drilling commenced in July 1981, and subsequent cruises have been conducted on a seasonal basis (November, February, May, and July) over a three year period. On each cruise, samples were collected at regional stations 1-18 (fig. 1A) and at 29 site-specific stations (fig. 1B). Regional stations 19, 20, and 21 were added to the program during the July 1983 cruise. Locations indicated by a triangle on figure 1A are sites of sediment cores that were taken on other cruises during the postdrilling period. The 18 regional stations were positioned to evaluate changes with time over different environments within the entire region. For example, stations 13 and 13A are thought to be areas of deposition for material winnowed by currents from Georges Bank (Bothner and others, 1981; Twichell and others, 1981), as are stations 14 and 14A in the Gulf of Maine and stations 7A and 9 in the heads of Lydonia and Oceanographer Canyons. Station 15 is in an area of eroding coarse sediment. Given the mean current flow to the west on the southern flank of Georges Bank (Butman and others, 1982a), the stations in transect I (stations 1, 2, and 3) are considered to be upstream controls for stations among the major lease blocks (transect II) and for stations downstream of the lease blocks (transect III). (Station 13A was added on cruise 4. Because the sediment texture varied considerably over short distances at stations 7 and 14, the positions were changed in the second year of the program to locations labeled 7A and 14A; see fig. 1A. Stations 15 and 14A were discontinued after the eight and ninth cruises, respectively.)

The site-specific survey, designed to monitor changes close to a rig, was centered around the platform operated by Mobil in block 312 (regional station 5), where drilling took place between December 1981 and June 1982. A less detailed local survey was conducted with three stations (regional

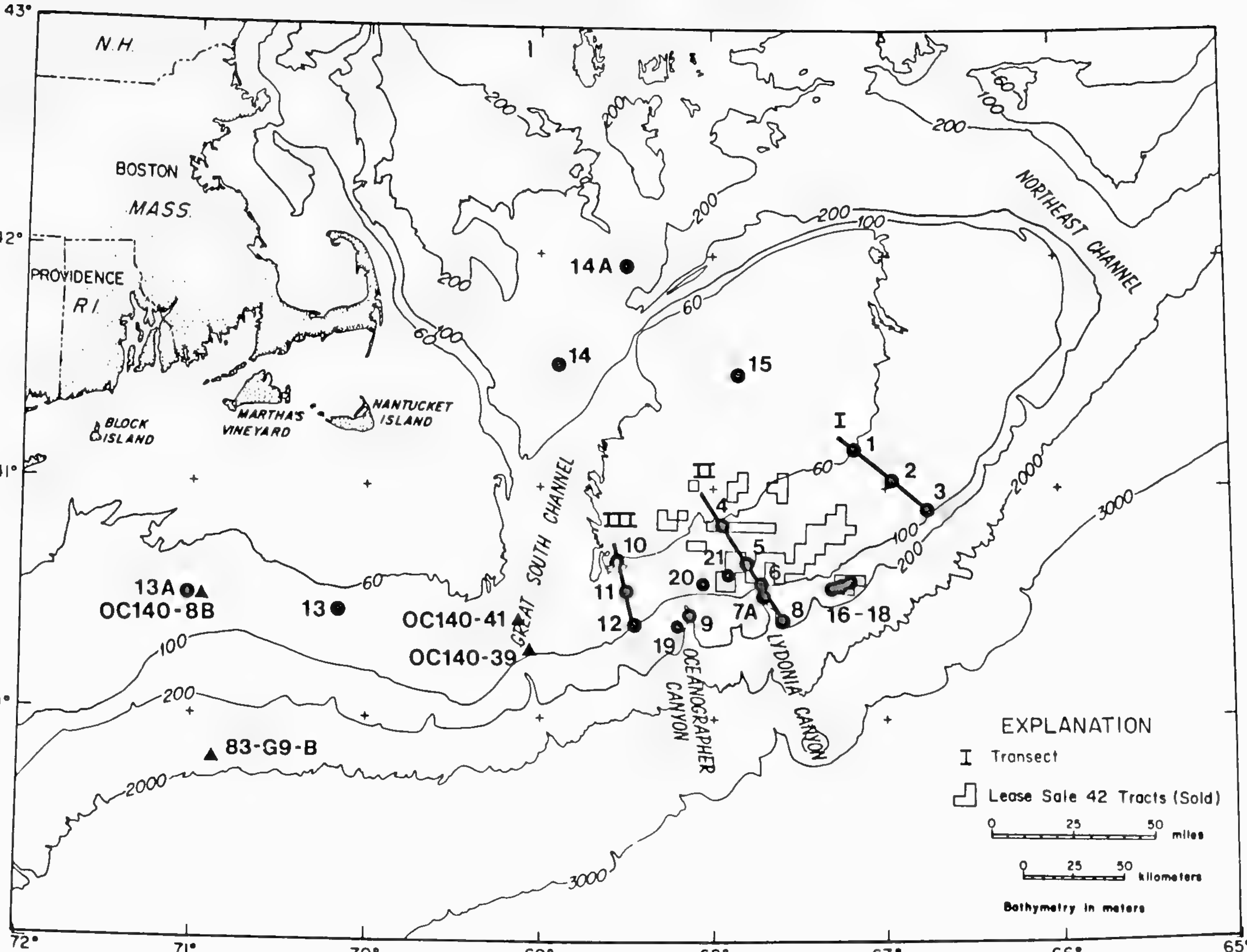

FIGURE 1A. Regional sampling station array. Site-specific array in block 312 is centered at station 5. Triangles indicate locations of cores analyzed during the third year of monitoring. Station 7 is within the area covered by the dot labeled 7A.

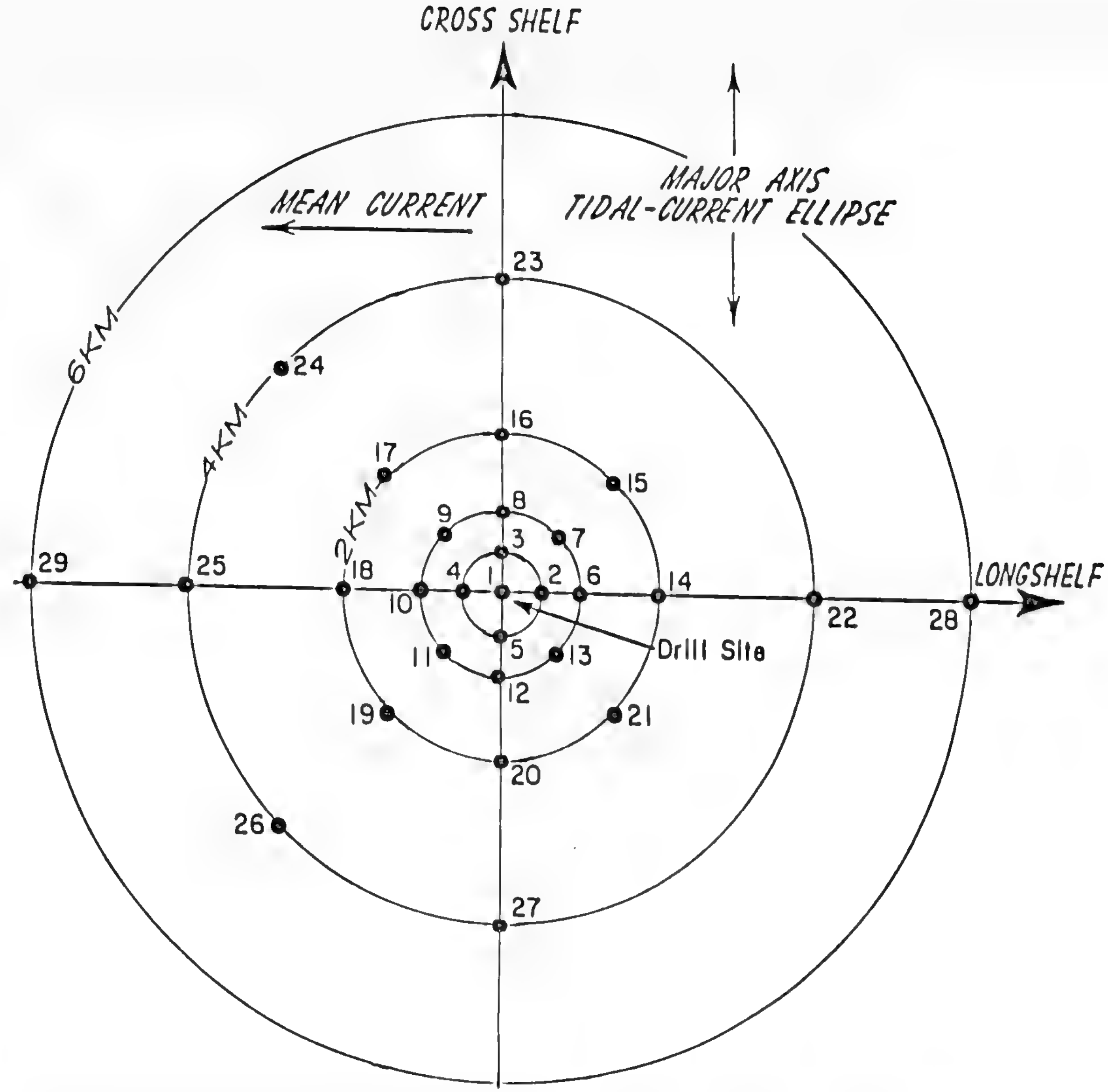

FIGURE 1B. Site-specific sampling station array around regional station 5 (block 312). Stations 5-7, 5-13, 5-15, 5-17, 5-19, 5-21, 5-23, 5-24, 5-26, and 5-27 are secondary stations (of lower priority) and have not been analyzed routinely.

stations 16, 17, and 18) near the Shell Oil Company platform that operated in block 410 between July 1981 and March 1982.

Eight exploratory wells have been drilled to date on Georges Bank. The first was started on July 22, 1981, and the last well was completed on September 27, 1982. Each of the exploratory wells was classified as a dry hole with no commercial quantities of hydrocarbons. There has been no additional drilling on Georges Bank in the period between September 27, 1982 and February 15, 1985.

FIELD SAMPLING AND SAMPLE PREPARATION

Positioning of the ship on each cruise was based on the Loran-C navigation network. A Northstar 6000 (Digital Marine Equipment Corp., Bedford, Mass.) receiver was used to read time delays and calculate latitude and longitude. The latitude and longitude values reported are not as accurate as those calculated using a more modern algorithm, and workers who wish to plot or re-occupy the stations of this program should rely on the time delay values rather than the latitude and longitude. Samples were collected when the ship was within ±0.3 μs of the target time delays for each station. At station 5, for example, this converts to an error in positioning of ±140 m drms (distance root mean square; see Bowditch, 1977, p. 1231). Navigation data for each sample analyzed for chemistry are compiled in appendix tables 1A, 1B, and 1C.

Special steps were taken to minimize contamination of sediment samples at sea. The samples for chemical analyses were collected with a 0.1-m^2 stainless steel Van Veen grab sampler with teflon coating on all surfaces in contact with sediment. A polyethylene-coated cable was used to lower the grab to the sea floor. Upon recovery of a sample, the overlying water was siphoned off

with a glass tube, and the upper 2 cm of material were (1) collected with a noncontaminating utensil, (2) placed in an acid-washed polyethylene container, and (3) frozen until analyzed. Because individual grab samples were subsampled for both trace-metal and hydrocarbon analyses, the grab sampler was rinsed with distilled methanol and hexane before each use.

Sediment cores were collected on other USGS cruises in the study area with a hydraulically damped gravity corer similar to the one described by Pamatmat (1971). This apparatus has a slow rate of penetration controlled by a water-filled piston, and it collects cores as long as 70 cm (in mud) with minimal disturbance of the sediment. Cores containing the undisturbed water-sediment interface were collected in thin-walled fiberglass core barrels and were frozen after collection. The samples were later extruded, thawed, and cut into 1-cm sections for analysis.

Core 83G9-B was collected from the Continental Slope (fig. 1A) using a conventional box corer. A subcore was sectioned into 1-cm depth intervals. The depth distribution of metals also was determined on samples removed in 2-cm depth intervals from grab samples.

In the laboratory, the samples were thawed, homogenized, and subsampled under a laminar flow hood. Aliquots from individual grabs and sample blends, made up of equal weights from the individual grabs, were separated for chemical and textural analyses. Samples for chemical analyses were dried to a constant weight at 70°C in an oven having teflon-coated surfaces and a filtered nitrogen atmosphere. Dried samples were ground in an agate grinder after shell or sediment particles larger than 2 mm were removed. Drill cuttings, identified by their angular edges and unusual color, were not removed. These samples are referred to as bulk sediments (undifferentiated with respect to size) throughout this report.

To maximize the analytical resolution in identifying drilling mud components, sand and coarser material were removed from selected samples. Filtered distilled water was used to wash the silts and clays through a 60-µm nylon sieve. (A 63-µm sieve, used to separate sand from finer material in the standard textural analyis procedures, was unavailable in a non-metal material.) The resultant slurry was dried in a teflon-coated oven, then ground and analyzed by the same methods used for bulk sediments. Corrections were made for the weight of salt contributed by the interstitial water using the following relation between chlorinity (Cl) and salinity (S);

$$S = 0.03 + 1.805\ (Cl)$$

(Sverdrup and others, 1942). Chloride was measured in samples of the separated fine fraction using the method of Aruscavage and Campbell (1982). This technique utilizes a specific ion electrode that measures most of the bromide as chloride and thus estimates the total chlorinity of the sample. The ratio of measured chloride to the total precipitated sea salts used to make salt corrections was 0.5535. The algorithm for making corrections for each metal concentation is:

$$C = U/\ (1 - (Cl/0.5535))$$

where C is the corrected metal concentration, U is the uncorrected concentration, and Cl is the measured chloride concentration in percent multiplied by 10^{-2}.

The field numbers (for example, M09-13-00-G and M10-05-28-BL) that identify samples in each data table have the following code. The first three characters indicate the cruise number; M09 stands for monitoring cruise 9. The station number appears after the first dash. In the examples given, 13-00 is a station in the regional sample array; station 05-28 is one of the site-specific stations around regional station 5 (see fig. 1B). A single alpha

character at the end of the field number identifies one of three replicates taken at each station for trace-metal analysis. Alternatively, the notation BL at the end of the field number indicates a blended composite sample made up of equal weights from each of the three replicates. Field numbers ending in X indicate that analyses were performed on the fraction of sediment finer than 60 µm.

GRAIN-SIZE ANALYSIS TECHNIQUES

Textural analyses were performed on wet sediments to avoid the formation of clay aggregates. Homogenized samples were wet-sieved by using a dispersant (5-percent Calgon) through a 63-µm sieve to remove silt and clay. The coarse fraction (containing shells, if present) was dried, weighed, and then sieved through a 2-mm screen to remove the gravel, which was not further sized. The sand fraction was analyzed with a Rapid Sediment Analyzer (Schlee, 1966). A gravimetric determination of the silts and clays was made by filtering. The size distribution of the silts and clays was determined with a Coulter Counter. Statistical parameters (mean, median, standard deviation, and so forth) were determined by the method of moments (Krumbein and Pettijohn, 1938). All textural data are expressed in phi (ϕ) units, which are defined as $-\mathrm{Log}_2 D$ where D is the grain diameter in millimeters.

Samples from sediment traps, cores, and depth profiles from grab samples were often too small for a complete textural analysis. In such cases, the samples were passed through a 60-µm nylon sieve and the percentage of dry sediment coarser and finer than 60 µm was determined gravimetrically.

TRACE-METAL ANALYSIS PROCEDURES

The analyses of trace metals in marine sediments were carried out by the U.S. Geological Survey Branch of Analytical Laboratories, Reston, Va. Concentrations of the following elements were determined: aluminum (Al), barium (Ba), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni), vanadium (V), and zinc (Zn). Analyses were carried out by the U.S. Geological Survey Branch of Analytical Laboratories, Reston, Va. The various procedures employed in each of the analyses are detailed below and summarized in table 1.

Preparation of stock solution A

Exactly 0.5 g of ground bulk sediment or 0.2 g of the fine fraction was added to a covered teflon beaker and digested overnight with 5 mL of $HClO_4$, 5 mL of HNO_3, and 13 mL of HF at approximately 140°C. The covers were removed and the temperature was increased to between 180° and 190°C, first producing fumes of $HClO_4$ and then evaporating the solution to dryness. The residue was dissolved and diluted to exactly 25 mL with 8 N HCl. This solution is referred to as stock solution A.

Two blanks containing all reagents were analyzed along with samples. All reagents were analyzed for contaminants prior to use, as is always necessary. The Canadian reference sediment standard MESS-1 was analyzed in each set of samples. A series of solutions was prepared that approximated the concentration levels expected in the samples; this series was used as the standard in calibrating the inductively coupled plasma (ICP) spectrometer and atomic absorption (AA) spectrophotometer.

Table 1. Summary of analytical conditions

Element	Instrument	Instrument conditions	Extraction procedure	Procedure determination limit in sample, µg/g	Average blanks, as measured in µg/g in solution
Al	ICP (argon)	308.2 nm FP (Forward power)=1.1 kw Fixed cross flow nebulizer Spectral band width 0.036 nm Observation height 16 mm.	None	50	0.02
Ba	ICP (argon)	455.4 nm FP=1.1 kw Fixed cross flow nebulizer Spectral band width 0.036 nm Observation height 16 mm.	None	20	.01
Cd	Graphite furnace AA.	110°C dry temperature 250°C char temperature 2100°C atom temperature Regular graphite tube Interrupt gas flow W.l.=228.8 nm Slit=0.7 nm.	Butyl acetate and DDTC.	0.02	.0002
Cr	Graphite furnace AA.	110°C dry temperature 900°C char temperature 2700°C atom temperature Regular graphite tube Normal gas flow (low) W.l.=357.9 nm Slit=0.7 nm.	None	2	.003
Cu	Graphite furnace AA.	110°C dry temperature 850°C char temperature 2700°C atom temperature Regular graphite tube Interrupt gas flow W.l.=324.7 nm Slit=0.7 nm.	Butyl acetate and DDTC.	1	.005
Fe	ICP (argon)	259.9 nm FP=1.1 kw Fixed cross flow nebulizer Spectral band width 0.036 nm Observation height 16 nm.	None	50	.02

Table 1. Summary of analytical conditions - (continued)

Element	Instrument	Instrument conditions	Extraction procedure	Procedure determination limit in sample, µg/g	Average blanks, as measured in µg/g in solution
Hg	Induction furnace AA.	Wavelength=254 nm Cold vapor AA.	None	0.005	0.005
Mn	ICP (argon)	257.6 nm FP=1.1 kw Fixed cross flow nebulizer Spectral band width 0.036 nm Observation height 16 nm.	Butyl acetate (removal of iron).	10	.006
Ni	Graphite furnace AA.	110°C dry temperature 900°C char temperature 2700°C atom temperature Pyrolytic tube Normal gas flow (low) W.l.=232.0 nm Slit=0.2 nm.	None	2	.02
Pb	Graphite furnace AA.	110°C dry temperature 500°C char temperature 2700°C atom temperature Regular graphite tube Interrupt gas flow W.l.=283.3 Slit=0.7 nm.	Butyl acetate and DDTC.	1	.02
V	Graphite furnace AA.	110°C dry temperature 1000°C char temperature 2800°C atom temperature Pyrolytic curtin tube Normal gas flow (high) W.l.=318.4 nm Slit=0.7 nm.	None	3	.002
Zn	Flame AA.	Oxidizing; air-acetylene flame W.l.=213.9 Slit=0.7 nm.	Butyl acetate	1	.01

Preparation of stock solution B

Stock solution B was made by adding 10 mL of butyl acetate (distilled to remove impurities such as copper) to 15 mL of stock solution A in a 60-mL separatory funnel. This solution was vigorously agitated by an automatic shaker for six minutes to extract iron. The layers were separated, and the extraction step was repeated with an additional 10 mL of butyl acetate. The aqueous layer was evaporated to dryness at 150°C in a 50-mL beaker. The residue was dissolved and diluted to 25 mL with 1 N HCl.

Barium

The measurements for Ba were made by ICP spectrometry with 2 mL of stock solution A diluted to 4 mL with distilled H_2O.

Aluminum, iron, chromium, nickel, and vanadium

Concentrations of Al and Fe were determined by ICP spectrometry by using 1 mL of stock solution A diluted to 10 mL with H_2O. The measurements for Cr, Ni, and V were made by injecting 20 µL of diluted (1:10) stock solution A into a graphite-furnace AA spectrophotometer.

Lead, copper, and cadmium

Fifteen mL of 0.5-percent (weight: volume) diethyldithiocarbamic acid diethylammonium salt (DDTC) in chloroform were added to 10 mL of solution B in a 60-mL separatory funnel and mixed for 10 minutes by an automatic shaker. The chloroform layer was drained into a 30-mL beaker and the aqueous layer washed with 10 mL of chloroform. The second chloroform layer was combined with the first, and the total volume of chloroform was evaporated to dryness at 90°C. The organic matter was destroyed by adding 0.1 mL of concentrated HNO_3 and was evaporated to dryness. This residue then was dissolved in 2 mL of warm 1 N HCl. The beaker was rinsed four times with 2 mL portions of distilled H_2O, and the solution was transferred to a small polyethylene

container. The measurements for Pb, Cu, and Cd were made by injecting 20 µL of the final solution into a graphite-furnace AA spectrophotometer.

Manganese and zinc

The measurements for Mn were made by ICP spectrometry with a solution made by diluting 2 mL of stock solution B to 4 mL with H_2O. Zinc was measured by flame AA directly from stock solution B.

Mercury

Mercury concentration was determined on a separate portion of the sample. Two hundred milligrams of sediment (100 mg if sample concentrations were expected to be >50 ppb) were decomposed in a 1-oz teflon screw-top vial with 2 mL of concentrated HNO_3 (J. T. Baker Chemical Co.) and 2 mL of $HClO_4$ (G. Frederick Smith Chemical Co. (GFS) double distilled from Vycor, a pure silica glass). The mixture was heated in a capped vial until the solution reached 200°C. The solution was then heated with the cap off for about 45 minutes, after which the samples were removed from the heat source. Immediately, 1 mL of concentrated HNO_3 was added; the vial was filled with H_2O and capped tightly until used. The sample solution then was added to a flask containing 125 mL of H_2O and 4 mL of 10-percent (weight:volume) $SnCl_2$ in 20-percent HCl. Nitrogen was passed through the solution to remove elemental Hg, which was collected on gold foil located in the center of the coils of an induction furnace. Activation of the furnace released the Hg, which was measured by a cold-vapor AA technique. Blanks, standard rocks, and internal sediment standards were analyzed for each set of samples. A series of solutions was prepared that had the same Hg- concentration range expected in the samples.

The concentrations of Hg in bottom sediments determined during the first year of the monitoring program were typically less than the detection limit of

0.01 ppm. During the second and third year of monitoring, we tested new procedures designed to lower the detection limit.

The contribution of Hg from various brands of nitric acid was determined. Baker "analyzed reagent grade" contained <0.5 parts per billion (ppb) Hg, the lowest concentration of the acids tested. Baker "ultrex" contained 2 ppb Hg, and Mallinckrodt nitric acid contained 1.3 ppb Hg. During the checks of $HClO_4$, we found that some bottles of GFS double distilled $HClO_4$ contained 5 ppb Hg. We ultimately selected GFS double distilled from Vycor which was found to contain <0.5 ppb Hg. The Hg concentration of each new bottle of acid and of every other reagent was determined before the reagent was used for analysis. The Hg contribution from the combined reagents was reduced to 0.5 ng±0.1 ng.

We tried to lower the detection limit by increasing the sample size. Subsamples weighing 1 g were analyzed with various combinations of nitric and perchloric acids. The results were not encouraging because digestion was incomplete using small acid volumes or because blanks were too high when large acid volumes were used. The high sediment concentration in suspension during the gas-stripping procedure may have adsorbed some of the Hg, accounting for the lower concentration measured for large samples.

Another method of increasing sample size involved successive plating of Hg vapor from three 200-mg aliquots onto the gold foil of the induction furnace. This technique yielded poor reproducibility among replicates and decreased the number of samples that could be analyzed in a day by a factor of 3.

The selection of reagents having the lower Hg concentration, addition of a digital readout voltmeter, and optimization of the optical system in the cold-vapor AA detection system (manufactured by Laboratory Data Control, Inc.) reduced the detection limit of our procedure from 0.01 ppm to 0.005 ppm.

The magnitude of Hg lost while oven drying sediment samples also was evaluated. Aliquots of bulk sediments from station M06-13A and aliquots of the fine fraction from station M05-16 were analyzed wet and the results compared to samples that were oven dried at different temperatures. We found no evidence of Hg loss as a result of drying bulk sediments at temperatures between 40° and 100°C, but some loss (about 42 percent) was observed when drying fine-fraction samples at 100°C.

Additional methods

Results of Ba and Cr analyses on selected Georges Bank samples were cross-checked by an energy-dispersive X-ray fluorescence technique (Johnson, 1984). The determination of Ba concentration was made with a Kevex 0700 energy-dispersive X-ray fluorescence spectrometer. Powdered samples of about 1 g were analyzed with a gadolinium secondary target for excitation of the K-alpha line. The ratio of Ba intensity to the gadolinium Compton Scatter intensity was used to correct for absorption effects. This ratio then was compared to a standard calibration curve to determine the concentration of Ba.

The X-ray fluorescence technique was used on all samples found to have more than 500 ppm Ba during the first analysis by acid decomposition and ICP spectrometry. The X-ray fluorescence technique is highly accurate in samples enriched with $BaSO_4$, which are difficult to dissolve completely. Justification of the alternative methods is presented in Bothner and others (1982).

ANALYTICAL ACCURACY AND PRECISION

Analytical accuracy was determined by analyzing rock standard MESS-1. Excellent agreement occurs between our results and values established by other laboratories (table 2). Excellent agreement also exists among aliquots of samples submitted as blind replicates (appendix table 2).

Table 2. - Analysis of sediment standard and replicate sediment samples

Sample standard	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)
MESS-1------	5.40	270	0.41	50	23	2.9	480	36	32	80	160
	5.20	270	.44	52	23	2.9	460	36	31	72	170
	5.20	270	.44	52	23	2.9	460	34	30	79	170
	5.40	260	.45	54	23	2.9	470	36	30	72	180
	5.50	260	.45	52	23	2.9	470	36	30	79	170
	5.30	270	.44	50	24	2.9	470	36	31	76	170
	5.50	260	.45	52	24	2.9	450	37	37	74	190
	5.40	260	.49	48	25	2.9	510	35	38	70	160
	5.60	270	.39	48	25	2.9	490	37	34	78	170
	5.50	270	.53	52	29	3.0	470	35	37	82	170
	5.50	270	.47	51	26	2.9	500	30	32	70	160
	5.70	280	.46	50	28	3.0	480	37	36	78	160
$\bar{x}$----------	5.43	267	.46	51	24.8	2.92	476	35.4	33.3	75.5	170
σ----------	.15	7	.03	1.8	2.1	.04	18	2.0	3.2	4.1	8.9
CV(%)[1]------	2.9	2	7.6	3.6	8.4	1.4	4	5.7	9.6	5.4	5.3
Best value[2]	5.8	270	.59	71	25	3.0	513	30	34	72	191
σ----------	.2		.1	11	4	.2	25	3	6	5	17

Sample standard	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)
MAG	7.40	430	.14	88	27	4.6	710	64	22	110	140
	7.60	440	.15	93	28	4.6	720	64	22	110	140
	7.60	430	.13	92	30	4.6	700	60	21	120	140
	7.40	430	.15	90	27	4.6	720	64	21	110	140
	7.50	440	.13	90	27	4.6	700	64	21	120	140
$\bar{x}$----------	7.50	434	.14	90.6	27.8	4.6	710	63.2	21.4	114	140
σ----------	.1	6	.01	2.0	1.3	0	10	1.8	.5	5.5	0
CV(%)[1]------	1.3	1	7.1	2.2	4.7	0	1	2.8	2.6	4.8	0
Best value	[3]8.9	[3]490	[3].15	[3]100	[3]33	[3]4.9	[3]710	[3]53.8	[3]26	[3]142	[3]148

Sample standard	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)
B-12	3.10	260	0.067	39	6.3	1.6	290	12	15	40	43
	3.20	260	.071	37	6.3	1.6	290	10	16	40	40
	3.10	250	.080	39	6.8	1.6	290	13	18	40	40
	3.20	260	.075	39	6.8	1.6	300	10	17	40	40
	2.80	260	.083	37	6.3	1.6	290	10	16	34	40
$\bar{x}$----------	3.08	258	.080	38.2	6.5	1.6	292	11	16.4	38.8	40.6
σ----------	.16	5	.006	1.1	.3	0	5	1.4	1.1	2.7	1.3
CV(%)[1]------	5.3	2	8.1	2.9	4.2	0	2	12.9	7.0	6.9	3.3

Sample standard	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)
M10-05-02-S2	.12	26	<.02	5.0	<.1	.30	240	<2	3.6	7.5	4.2
	.12	26	<.02	6.0	<.1	.30	240	<2	3.3	6.5	4.2
	.12	25	<.02	6.0	<.1	.30	240	<2	3.6	6.5	4.2
	.12	24	<.02	5.0	<.1	.30	240	<2	3.3	7.5	4.2
	.12	23	<.02	5.0	<.1	.30	240	<2	3.3	7.5	4.2
$\bar{x}$----------	.12	25	<.02	5.4	<.1	.30	240	<2	3.4	7.1	4.2
σ----------	0	1	0	.6	0	0	0	0	.2	.6	0
CV(%)1------	0	5	0	10.1	0	0	0	0	4.8	7.7	0

[1]Coefficient of variation.
[2]Values reported by the Marine Analytical Chemistry Standards Program, National Research Council, Canada.
[3]Value judged to be most appropriate based on multiple analyses conducted at USGS Analytical Labs, Reston, VA.

Table 2. - Analysis of sediment standard and replicate sediment samples-Continued

Sample standard	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)
M10-13AB1	4.50	280	.058	63	11	2.5	300	32	27	84	58
	4.70	290	.056	65	11	2.5	310	33	27	82	58
	4.60	280	.058	60	11	2.5	310	33	26	84	58
	4.70	280	.054	66	11	2.5	300	33	27	86	58
	4.50	290	.054	64	12	2.5	300	33	26	86	58
$\bar{x}$----------	4.6	284	.060	63.6	11.2	2.5	304	32.8	26.6	84.4	58
σ----------	.1	6	.002	2.3	.4	0	6	.4	.5	1.7	0
CV(%)[1]	2.2	2	3.3	3.6	4.0	0	2	1.4	2.1	2.0	0

Sample standard	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)
M10-13AB1x	5.20	290	0.055	61	12	2.6	310	30	26	78	65
	4.90	290	.050	59	12	2.6	300	29	26	84	66
	4.90	280	.038	60	12	2.6	310	29	27	81	66
	5.00	280	.038	61	12	2.6	310	29	27	81	65
	5.20	280	.046	61	12	2.7	310	29	27	78	65
$\bar{x}$----------	5.04	284	.050	60.4	12	2.62	308	29.2	26.6	80.4	65.4
σ----------	.15	6	.007	.9	0	.04	5	.4	.5	2.5	.5
CV(%)[1]------	3.0	2	14.9	1.5	0	1.7	2	1.5	2.1	3.1	.8

Sample standard	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)
M11-5-16B1	.28	43	<.02	3.5	<1	.29	150	<2	3.6	4.0	3.7
	.28	42	<.02	3.5	<1	.29	150	<2	3.7	4.0	3.7
	.28	42	<.02	3.5	<1	.29	150	<2	4.0	4.0	3.7
	.28	42	<.02	3.5	<1	.29	150	<2	3.7	4.0	3.7
	.28	42	<.02	3.5	<1	.29	150	<2	3.7	4.0	3.3
$\bar{x}$----------	.28	42.2	<.02	3.5	<1	.29	150	<2	3.74	4.0	3.62
σ----------	0	.5	0	0	0	0	0	0	.15	0	.18
CV(%)[1]------	0	1.1	0	0	0	0	0	0	4.1	0	4.9

Sample standard	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)
M11-16B1	.32	130	<.02	<2	<1	.18	110	<2	4.4	<2	5.0
	.32	130	<.02	<2	<1	.18	100	<2	4.4	<2	4.6
	.33	130	<.02	<2	<1	.18	110	<2	4.4	<2	4.6
	.33	130	<.02	<2	<1	.17	100	<2	4.4	<2	4.6
	.32	130	<.02	<2	<1	.17	100	<2	4.4	<2	4.6
$\bar{x}$----------	.32	130	<.02	<2	<1	.176	104	<2	4.4	<2	4.68
σ----------	.01	0	0	0	0	.005	6	0	0	0	.18
CV(%)[1]------	1.7	0	0	0	0	3.1	5	0	0	0	3.8

Sample standard	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)
M11-16B1x	2.30	2600	0.13	29	20	1.7	740	27	39	49	80
	2.30	2600	.10	31	21	1.7	740	28	42	49	80
	2.40	2700	.12	29	20	1.7	750	28	43	49	81
	2.30	2600	.11	28	19	1.7	740	27	41	49	80
	2.30	2600	.12	32	21	1.7	740	27	41	49	80
$\bar{x}$----------	2.32	2620	.12	29.8	20.2	1.7	742	27.4	41.2	49	80.2
σ----------	.04	45	.01	1.6	.8	0	5	.6	1.5	0	.5
CV(%)[1]------	1.9	2	9.5	5.5	4.1	0	6	2.0	3.6	0	.6

[1]Coefficient of variation.

Table 2. - Analysis of sediment standard and replicate sediment samples-Continued

Sample standard	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)
M12-19HX-2-4	3.90	230	.13	69	14	2.6	450	32	27	100	66
	3.90	230	.12	72	15	2.6	460	31	27	110	66
	3.90	230	.12	71	15	2.6	460	31	27	110	68
	3.90	230	.12	74	14	2.6	450	31	25	100	68
	3.90	230	.13	69	14	2.6	450	32	27	110	66
$\bar{x}$----------	3.90	230	.124	71	14.4	2.6	454	31.4	26.6	106	66.8
σ----------	0	0	.005	2.12	.5	0	6	.6	.9	5	1.1
CV(%)[1]-----	0	0	4.4	3.0	3.8	0	1	1.7	3.4	2	1.6

Sample standard	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)
OC140-39X8-10	4.00	200	.13	72	19	2.8	380	37	25	130	76
	3.90	200	.13	75	19	2.9	390	36	26	130	76
	3.80	200	.14	75	18	2.9	380	38	25	120	80
	3.80	200	.14	73	19	2.9	370	38	27	130	78
	3.80	200	.15	75	19	2.8	370	36	28	120	75
$\bar{x}$----------	3.86	200	.138	74	18.8	2.86	378	37	26.2	126	77
σ----------	8.9	0	.008	1.4	.5	5.5	8	1	1.3	5.5	2
CV(%)[1]	2.3	0	6.1	1.9	2.4	1.9	2	2.7	5.0	4.3	2.6

[1]Coefficient of variation.

Analytical precision was determined by periodically analyzing replicate aliquots taken from a single sample. Coefficients of variation shown in table 2 indicate that the standard deviation is typically less than 10 percent of the mean value, except for concentrations at or near the detection limit of the method.

To maintain our internal quality control and to provide typical sample material for interlaboratory comparisons, four sediment standards representing different textural types were prepared from large samples of Georges Bank sediment. The levels of trace metals are being established by several analytical methods. Splits of these materials are available to those interested in cross-calibration studies.

RESULTS AND DISCUSSION

Sediment texture

The texture of the surface sediments sampled in the third year of monitoring (appendix table 3A) is very similar to the texture measured in the first two years (fig. 2) as defined by the average mean ϕ values at each station for a given year. Low yearly variability of the mean ϕ grain sizes occurs, as demonstrated by the close match of the data patterns. Mean ϕ values range from about 1 ϕ (coarse sand) at station 5-1 to about 6.3 ϕ (medium silt) at station 13A located south of Martha's Vineyard. The error bars (standard deviation about the mean of samples from each of four seasons) indicate that the within-station variability is much smaller than the between-station variability.

The sediments on Georges Bank are typically greater than 95 percent sand and contain minor amounts of gravel, silts, and clays. The sand is primarily medium to coarse grained, and ranges in coloration from a clear or

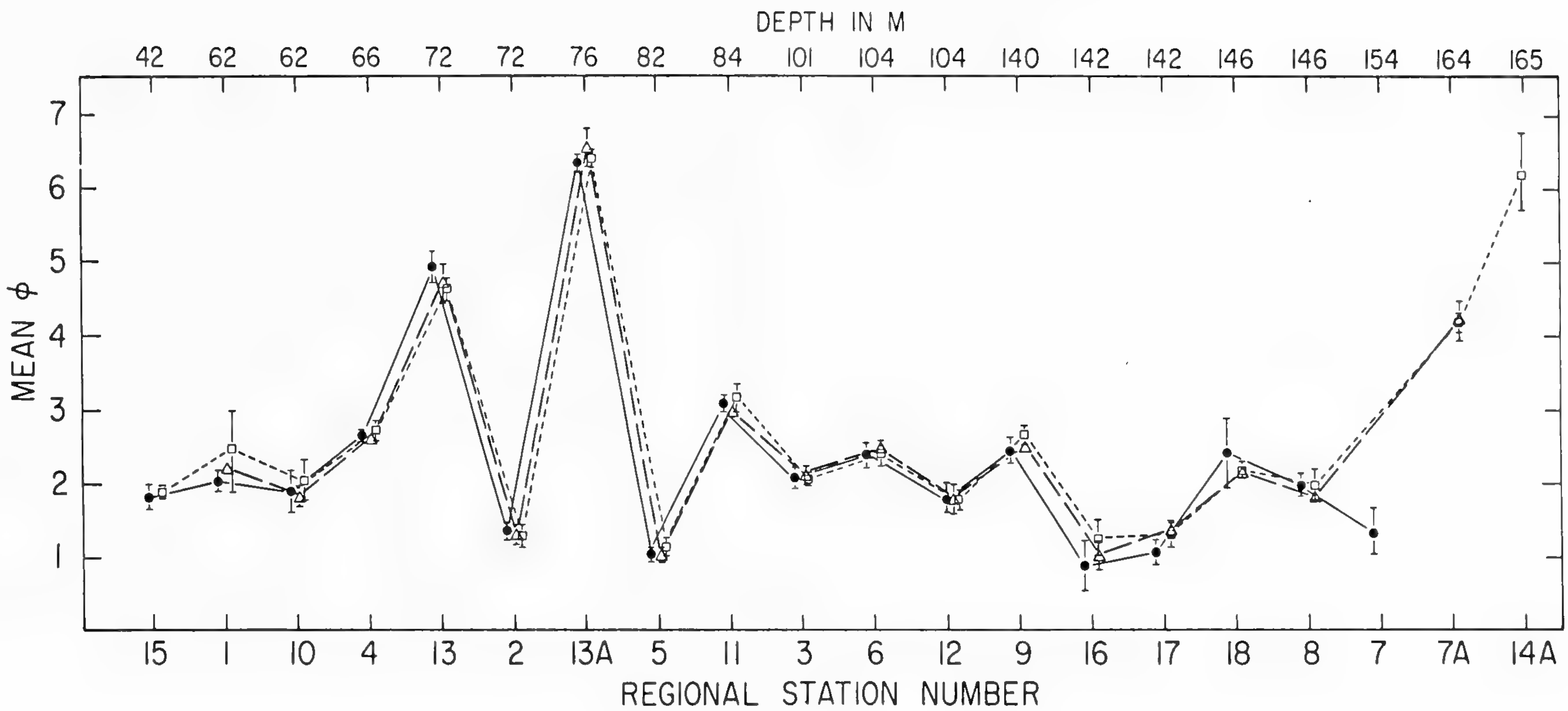

FIGURE 2. Mean grain size of samples collected during years 1 (circle), 2 (square), and 3 (triangle). Error bars represent the standard deviation among samples collected in a given year. Stations are listed in order of increasing water depth.

translucent yellow to a tan iron-oxide stain; it has an angular to subrounded grain shape. The minerals making up the sand fraction are primarily quartz with minor amounts of feldspar and trace amounts of heavy minerals. Authigenic minerals such as framboidal pyrite and ferromanganese micronodules have been found at various locations on the bank in very low concentrations (Poppe and others, 1984).

The concentrations of silts and clays in the regional samples are generally less than 4 percent (fig. 3), and the mean station values for year 3 are similar to those of years 1 and 2. The relative paucity of silts and clays reflects the strong winnowing processes associated with tidal and storm-generated currents on Georges Bank (Butman and Folger, 1979; Butman and Moody, 1983; Butman and others, 1982a; Parmenter and others, 1984). On sampling transects I, II, and III (fig. 1A), the content of sediment finer than 63 μm (silt plus clay) increases slightly toward the shelf edge, perhaps in response to increasing water depth.

Areas that showed a significant concentration of fine sediments (finer than 63 μm) during each sampling cruise were located at regional station 14A (80-90 percent fines) in the Gulf of Maine, regional station 7A (22-30 percent fines) at the head of Lydonia Canyon, and regional stations 13 and 13A (34-50 and 92-97 percent fines, respectively) located south of Nantucket Island. This last area, known as the Mud Patch, is thought to be one of the depositional sites for sediments from upstream areas on Georges Bank (Bothner and others, 1981; Twichell and others, 1981). The close correlation between the concentration of fine sediment, organic carbon, and trace metals was discussed in the report for year 1 (Bothner and others, 1982).

Determination of the major minerals in the clay fraction of the sediments by X-ray diffraction indicates that illite is predominant, with moderate

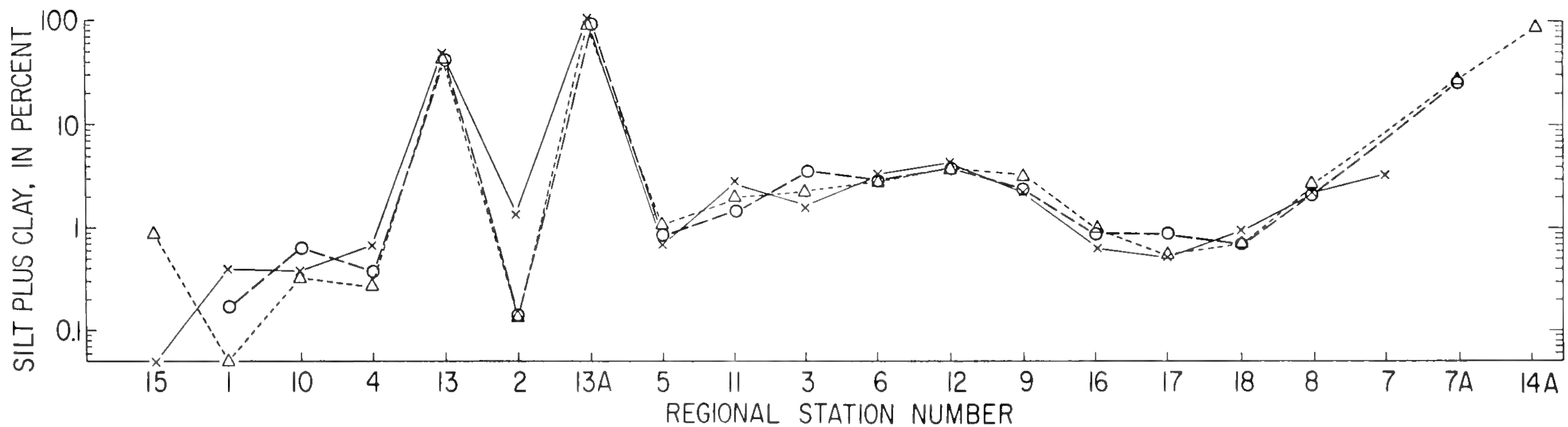

FIGURE 3. Percent silt plus clay in samples collected at each regional station during years 1 (x), 2 (triangle), and 3 (circle). Stations are listed in order of increasing water depth.

amounts of chlorite and small concentrations of kaolinite present (Bothner and others, 1979). Montmorillonite is present only in trace amounts or is absent. The origin of the illite and chlorite in the clay fraction is thought to be unweathered material eroded from Paleozoic and older rocks in the northern Appalachian region transported to the Continental Shelf during glacial periods (Hathaway, 1972).

The concentration of gravel is variable, ranging from 0 to almost 20 percent (appendix table 3A). The gravel is composed of rock fragments or shell hash or a mixture of both. Drill cuttings were observed in the gravel fraction at the drill sites in blocks 312 and 410. A few cuttings were found at station 17, 2 km to the east of the drill site in block 410 during both year 2 and year 3. On cruise 9, cuttings were observed at all stations within 500 m of the drill site in block 312. The cuttings are angular; they range in size from 2 to 8 mm and most are gray in color. Using X-ray diffraction analysis on a few cuttings, L. J. Poppe (USGS, written commun., 1984) identified calcite as the predominant mineral with lesser amounts of dolomite and layered silicates. These are common minerals throughout the subsurface Jurassic and Cretaceous sediments (Arthur, 1982). The highest concentrations of cuttings, which were localized at the drill sites, represent less than 1.5 percent of the total sample weight. The cuttings did not occur in a recognizable pile in the vicinity of the drill site in block 312, according to R. A. Cooper, National Marine Fisheries Service (written commun., Oct. 14, 1983), who conducted visual and photographic surveys of the drill site from a submersible.

Trace metals in bulk sediments

During the first year of this program, we established that the concentrations of trace metals in sediments collected before drilling began

were low compared to their average concentration in crustal rocks and that they were characteristic of uncontaminated coarse-grained sediments. We found the variability in trace-metal concentrations from station to station to be closely correlated with the content of fine-grained material and organic carbon in the sediments, as commonly occurs (Crecelius and others, 1975). Pb values higher than average crustal abundances were measured only at the location south of Martha's Vineyard where fine-grained sediments are accumulating and where previous studies (Bothner and others, 1981) have suggested tetraethyl lead from gasoline as a source of the elevated Pb found in this area.

Throughout the three years of monitoring, the concentrations of Ba in bulk sediments from the upstream control stations (transect I, stations 1-3) were fairly consistent with time (fig. 4, appendix table 4A). On the basis of these data, we judge that no increase in Ba had occurred at these stations. We found no increases in the concentration of other metals as a result of drilling at these upstream locations during the three years of monitoring.

In contrast, there were some measurable changes in the concentration of Ba in block 410 (stations 16, 17, and 18, fig. 5). Drilling began in this block immediately after the first sampling cruise in July 1981 and continued (with some interruptions) until March 31, 1982. The mean current flow on this part of the Continental Shelf is to the west, although tidal and storm currents can reverse the mean flow (Butman and others, 1982a). Relative to the mean current flow, stations 17 and 18 are upstream and downstream of the rig position, respectively (fig. 5).

At station 16, located within 200 m of the drill rig in block 410, average Ba concentrations apparently increased steadily from a predrilling concentration of 32 ppm to the maximum concentration of 172 ppm measured on

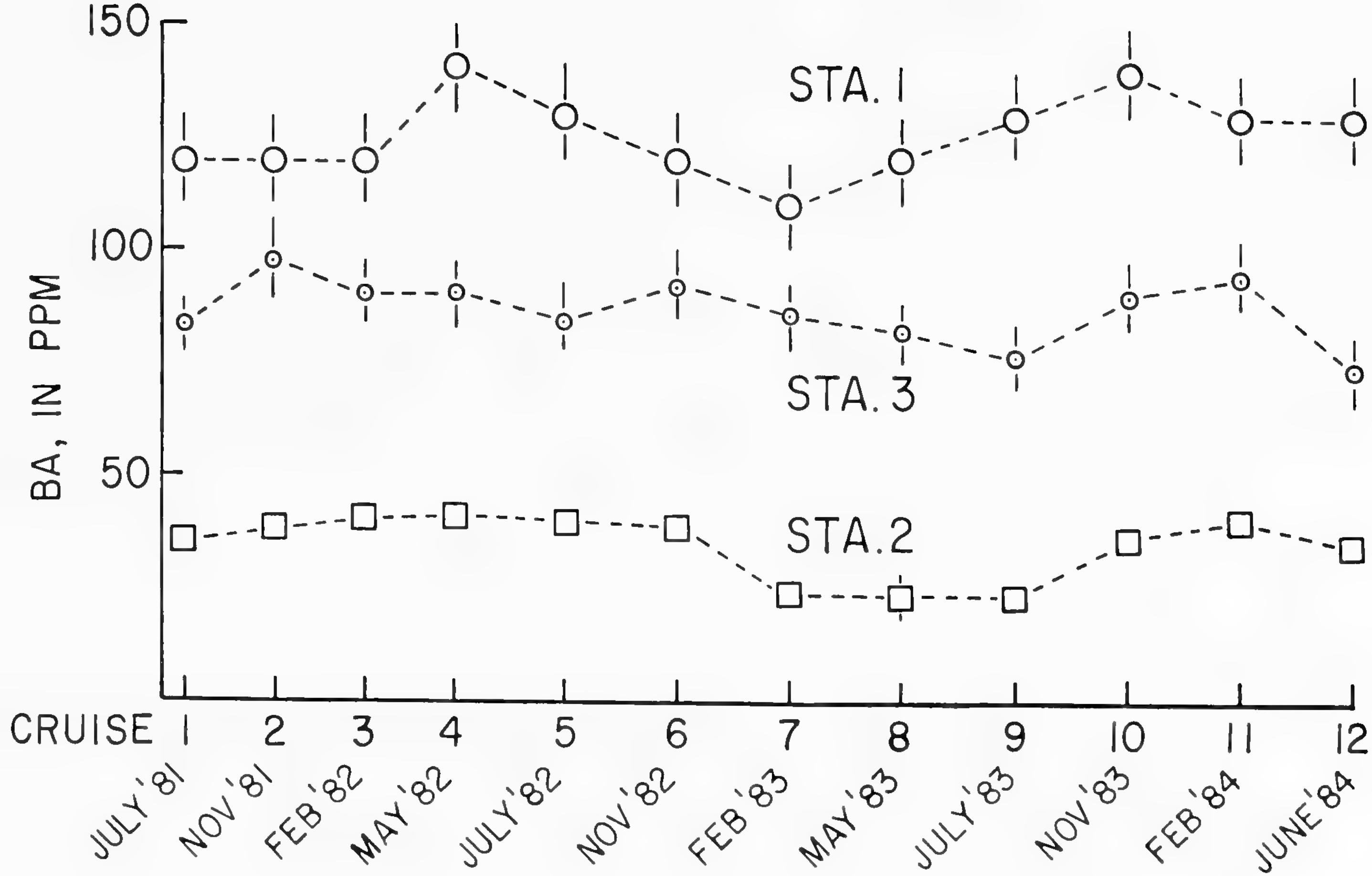

FIGURE 4. Concentrations of barium in bulk sediment at upstream control stations on different sampling occasions. Drilling began after the first cruise and ended at all locations before the sixth cruise. Station locations are shown in Figure 1A.

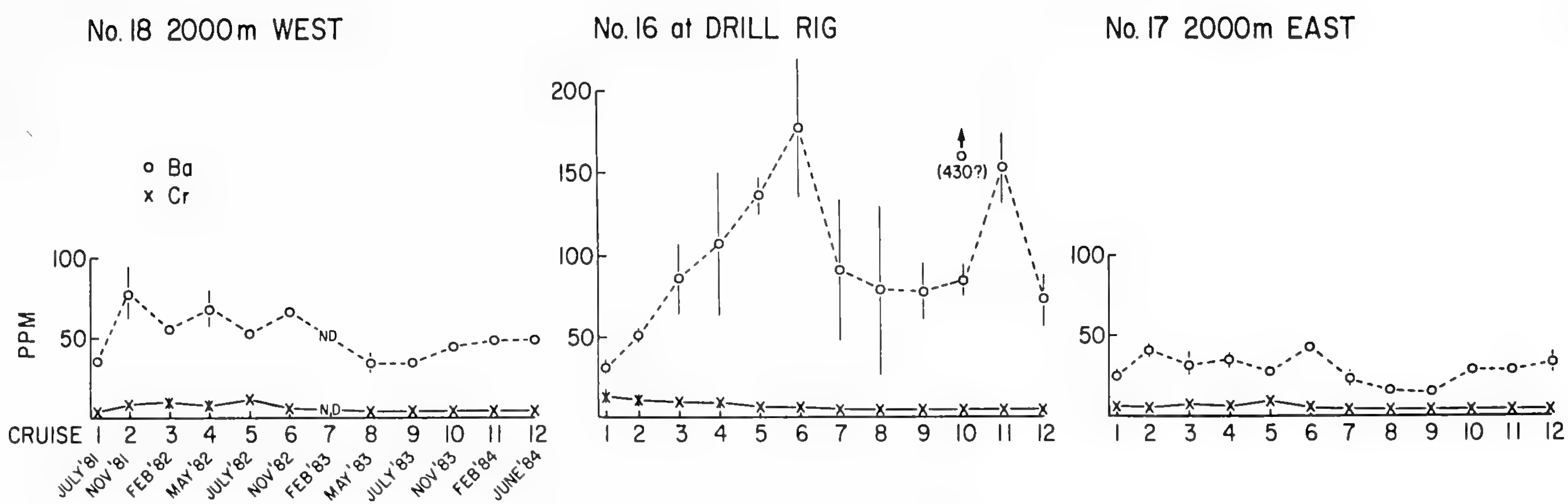

FIGURE 5. Concentrations of barium (circle) and chromium (x) in bulk sediment on different sampling occasions near the drill site at block 410. Drilling began after the first cruise and ended prior to the fourth cruise. Error bars are one standard deviation among three individual replicates. Anomalous value of 430 ppm in one of the three replicates at station 16 was omitted from calculation of the mean. ND=no data.

cruise 6, an increase by a factor of 5.9. Drilling was completed before cruise 4, and one would expect that the maximum concentration of Ba would be found on the fourth cruise. There is no statistical difference in the Ba concentration between cruises 4 and 6 at the 95-percent level of confidence (α=0.05) because of the large within-station variability in the Ba distribution (fig. 5).

The concentration decreases at the time of cruise 7, and except for cruise 11, remains at a fairly constant level of about 80 ppm from cruises 8 through 12. The anomalously high value of 430 ppm (fig. 5) was excluded from calculation of the mean. The scatter in the data probably indicates that Ba is not distributed homogeneously over the sampling area. This heterogeneity is probably caused by the intermittent discharge of drilling fluids into a current field that continuously changes direction of flow throughout the tidal cycle.

In agreement with the expected transport of drilling fluids to the west by the mean current flow, Ba concentrations were higher to the west than to the east. At station 18 (2 km to the west of the drill rig), maximum increase in Ba concentrations was about a factor of 2 as a result of drilling. The concentrations of Ba decreased to predrilling levels at the time of cruises 8 and 9 and then increased again. At the time of cruise 12, Ba concentrations were 36 percent higher than predrilling levels and the difference between mean values of cruises 1 and 12 is statistically significant at the 99-percent level of confidence (α=0.01). In contrast, at station 17 (2 km to the east), the maximum increase was only about 1.3 times the background Ba concentration. A decrease in concentration was also seen at this station for cruises 8 and 9 followed by an apparent increase. However, the concentration measured on cruise-12 samples is not significantly different at the 95 percent level of confidence from the cruise-1 concentration.

The concentration of Cr in these same samples (fig. 5) did not increase as a result of drilling even at the drill site. Similarly, we observed no changes in the concentrations of other metals in the bulk sediments during this period of monitoring.

In block 312 (station 5), the location of the site-specific survey, increases in Ba were observable following the initiation of drilling on December 8, 1981 (fig. 6). The greatest increase (factor of 4.7 above background) was observed at the drill site (station 5-1). At this location, there is a large standard deviation among three individual replicates and a considerable amount of scatter in the data following cruise 5. These trends are similar to those observed at station 16, also adjacent to a drill rig, and are thought to reflect the heterogeneity of drilling mud distribution in the sediments near the rig. At stations more than 0.5 km from the drill site, slightly higher increases were observed to the west than to the east, which is consistent with the preferential direction of transport. At all but station 5-10, the maximum concentration was observed during cruise 5, which was conducted immediately after drilling was completed. At most stations, the concentrations decreased rapidly by cruises 6 and 7 and remained essentially constant through cruise 12.

The concentration of Cr (fig. 6) or of other metals in bulk sediments at block 312 did not increase as a result of drilling.

Trace metals in the fine fraction of sediment

Within the sediment fraction finer than 60 μm (appendix table 4B), the Ba concentration increased dramatically at stations near the drill rig at block 410 (fig. 7). At station 16, adjacent to the rig, the average Ba concentrations reached 8,000 to 10,000 ppm between the third and seventh cruises. Lower concentrations were measured in four out of the last five

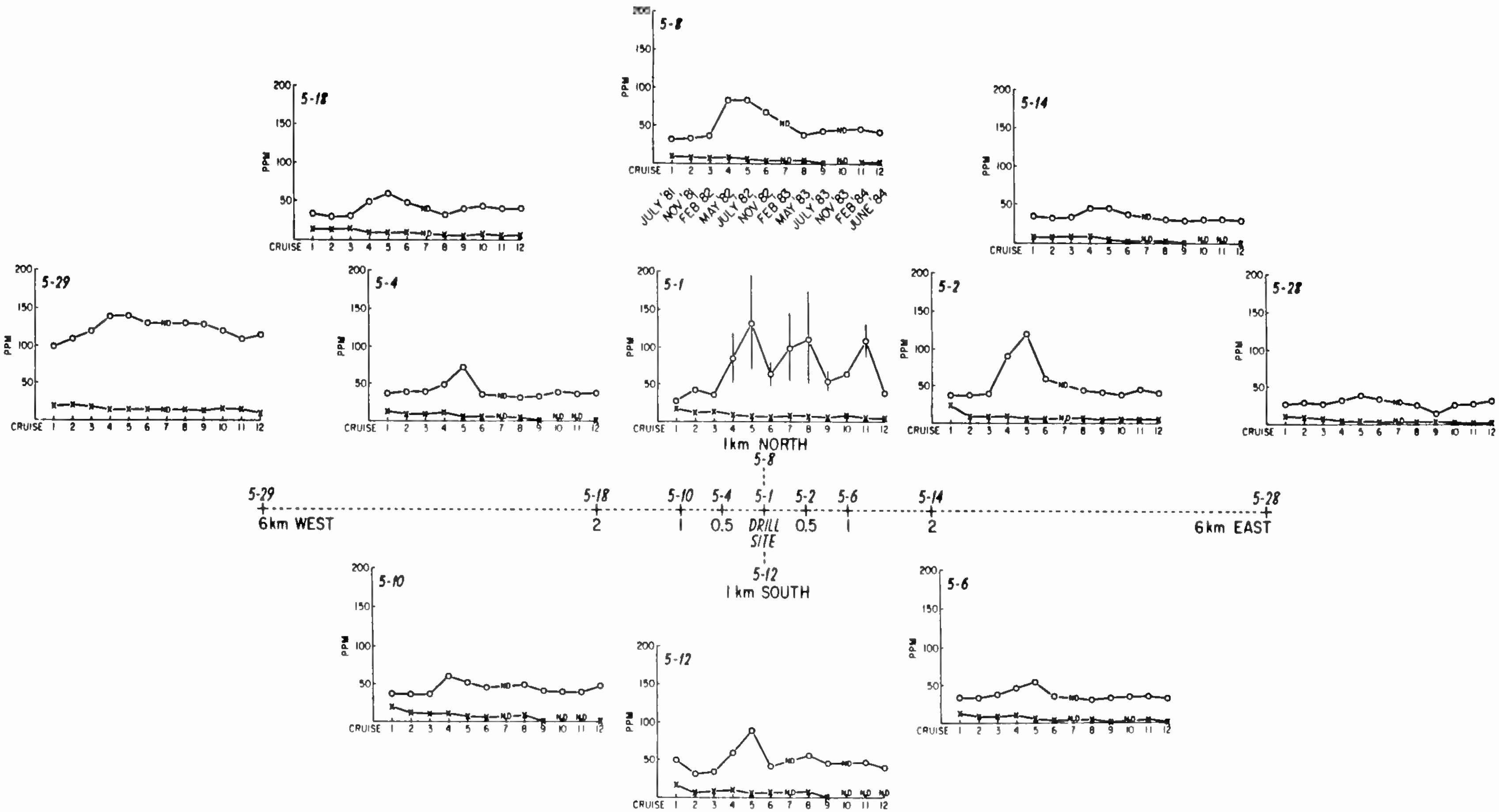

FIGURE 6. Concentrations of barium (circle) and chromium (x) in bulk sediment on different sampling occasions near the drill site at block 312. Stations are located on east-west and north-south transects through the drill site (see figure 1B). Drilling began after the second cruise and ended just before the fifth cruise. Error bars are one standard deviation among three individual replicates. ND=no data.

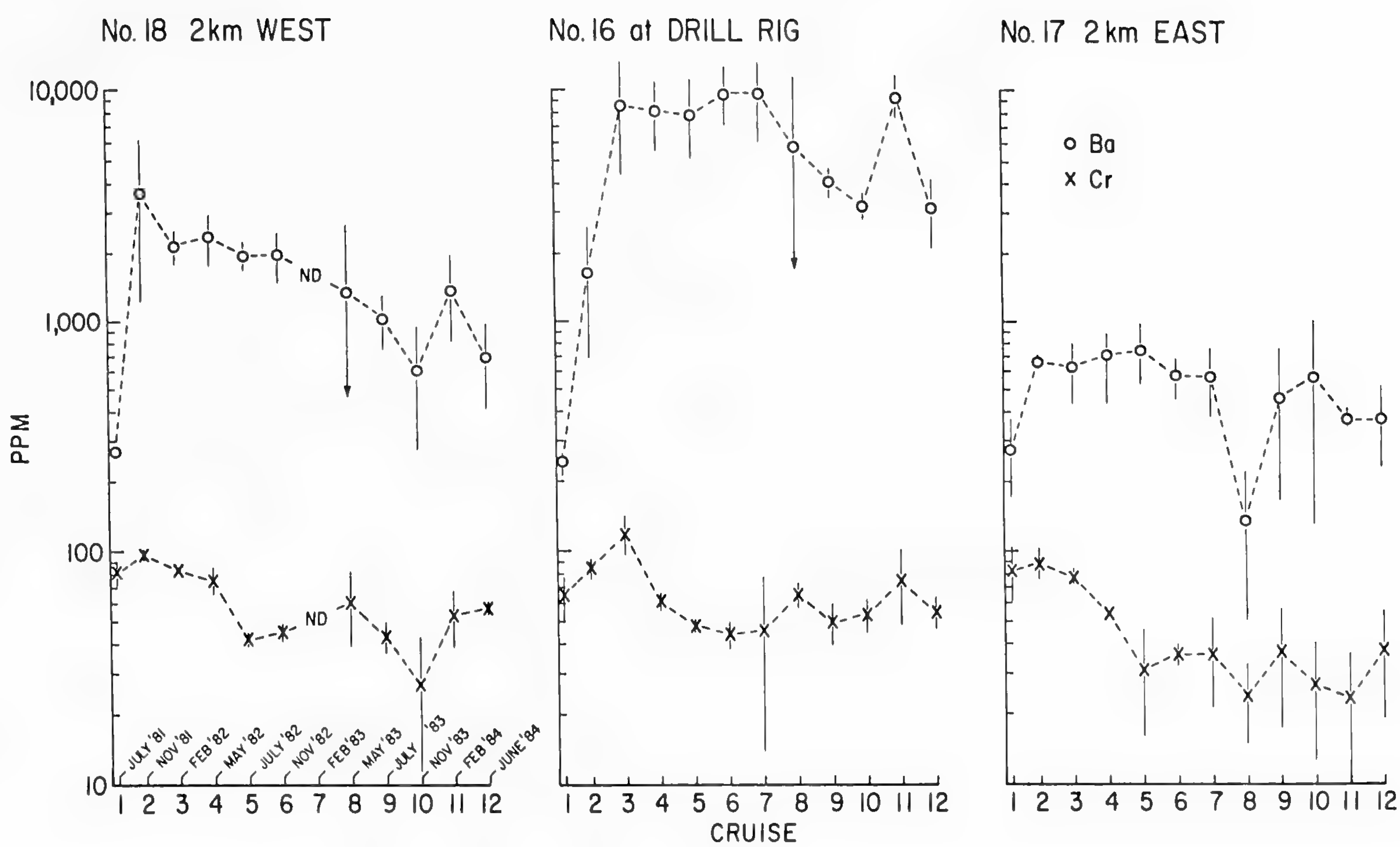

FIGURE 7. Concentrations of barium (circle) and chromium (x) in the fine fraction (less than 60 μm) on different sampling occasions near the drill site at block 410. Drilling began after the first cruise and ended prior to the fourth cruise. Error bars are one standard deviation among three individual replicates. ND= no data.

cruises, but by cruise 12, the concentration of Ba in the fine fraction was still more than ten times higher than in the predrilling sample. At station 17, 2 km upstream of the drill rig, the Ba concentrations increased less than at station 18, 2 km downstream of the drill rig. The effect of the mean westerly current flow, which would predict preferential transport to the west, seems to be illustrated by these data.

The concentration of Cr (fig. 7) increased slightly at station 16 in an apparent response to drilling, reached a maximum concentration of approximately 2 times background levels by the third cruise, and then decreased to background concentrations again. No increases in Cr concentration were observed at stations 17 or 18. The concentration of Al, Cu, and Hg in the fine fraction at station 16 also increased and decreased with similar magnitude and timing, as did that of Cr. We did not identify systematic increases of these metals at any other station.

At block 312, the drilling began just after the second cruise and was completed just before the fifth cruise. The Ba concentrations in the fine fraction of sediment clearly increased after drilling began and, at most stations, apparently decreased after the drilling ended (fig. 8). Concentrations of Cr did not increase during the drilling period. The other metals showed no changes attributable to drilling.

The temporal change of Ba in the fine fraction at the site-specific survey suggests a westward transport of Ba-rich fine sediment during this monitoring period. At station 5-28, the easternmost station of this detailed survey, the Ba concentration reach a lower maximum than at most other stations and, with the exception of cruise 10, are at or near background levels for cruises 7-12. At station 5-2, located 0.5 km east of the drill rig, Ba concentration reaches the maximum after the completion of drilling (cruises 4

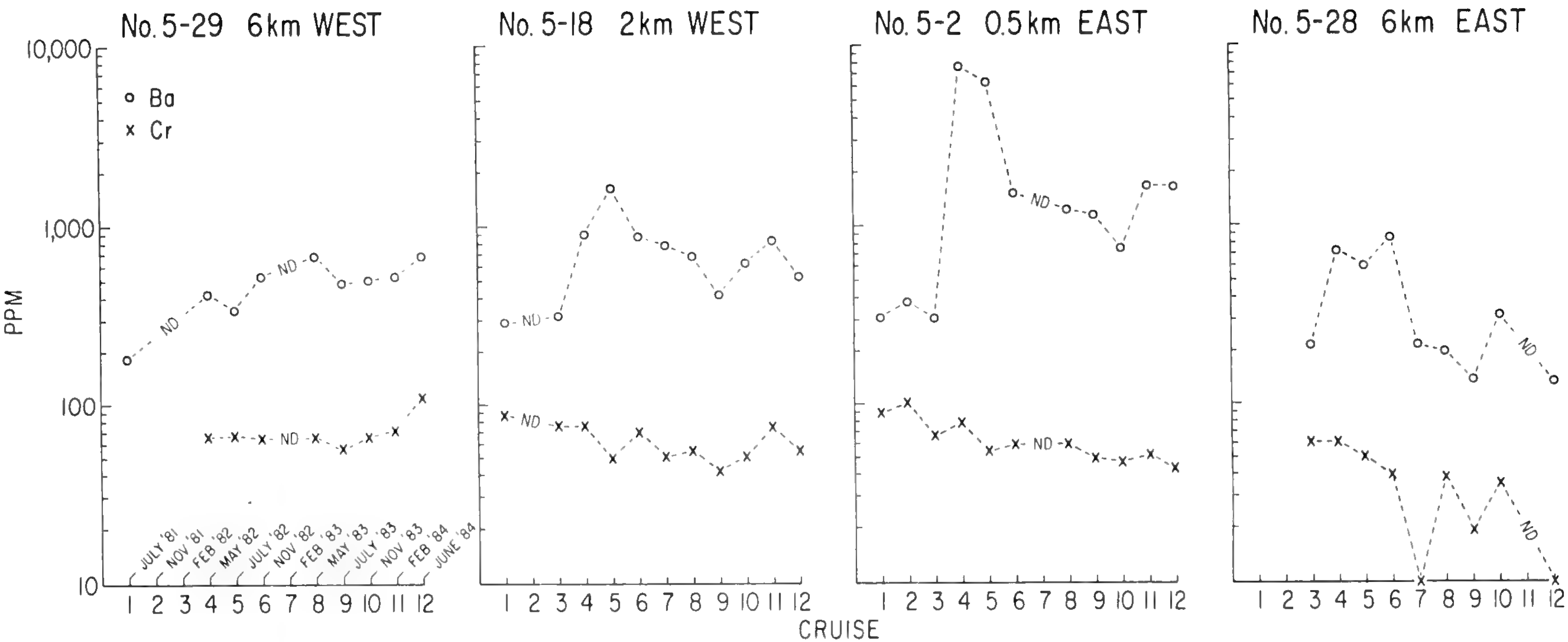

FIGURE 8. Concentrations of barium (circle) and chromium (x) in the fine fraction (less than 60 μm) on different sampling occasions near the drill site at block 312. Drilling began after the second cruise and ended just prior to the fifth cruise. ND= no data.

and 5) and decreases at the time of cruises 6 through 10. Ba concentrations at station 5-29, 6 km to the west, continue to increase between the completion of drilling and cruise 8. This continued postdrilling increase and maintenance of high concentrations through cruise 12 may be caused by the transport and deposition of Ba-rich fine sediment originally deposited closer to the rig. These results suggest that Ba was being dispersed from the immediate vicinity of the drilling rigs.

The question of how far the Ba from drilling mud could be traced was addressed by analyzing the fine fraction of sediment at stations 10 and 12, approximately 65 km west of the block 312 drill site, and stations 2 and 3, approximately 35 km to the east of the easternmost drill site. At stations 12 and 10 we measured maximums in the Ba concentration at the time of cruises 8 and 10, respectively (fig. 9A). We were surprised to record maximums in the Ba concentration at similar times, although of lower magnitude, at stations 2 and 3. The maximum value at station 3 on cruise 7 is statistically higher than the mean of the first 6 cruises at the 99.5 percent level of confidence (t test).

The Ba/Al ratio (fig. 9B) that was plotted for each sampling period is also used to show relative changes in the Ba levels. Typically Al is highly correlated with the percent of clay minerals in marine sediments and is used in the ratio to remove the variability introduced by different amounts of clay in the fine fraction on different sampling dates. The Ba/Al ratio also eliminates the small error introduced in making the chloride correction necessary to determine metal concentrations of the fine fraction in mass units. The Ba/Al ratio is at a maximum value at stations 2, 3, and 12 on cruises 7 or 8. The value for the relatively small maximum of station 3 is statistically higher (t test) at the 99.5 percent level of confidence than the mean of cruises 1-6. No Al data are available for samples from station 10.

A

B

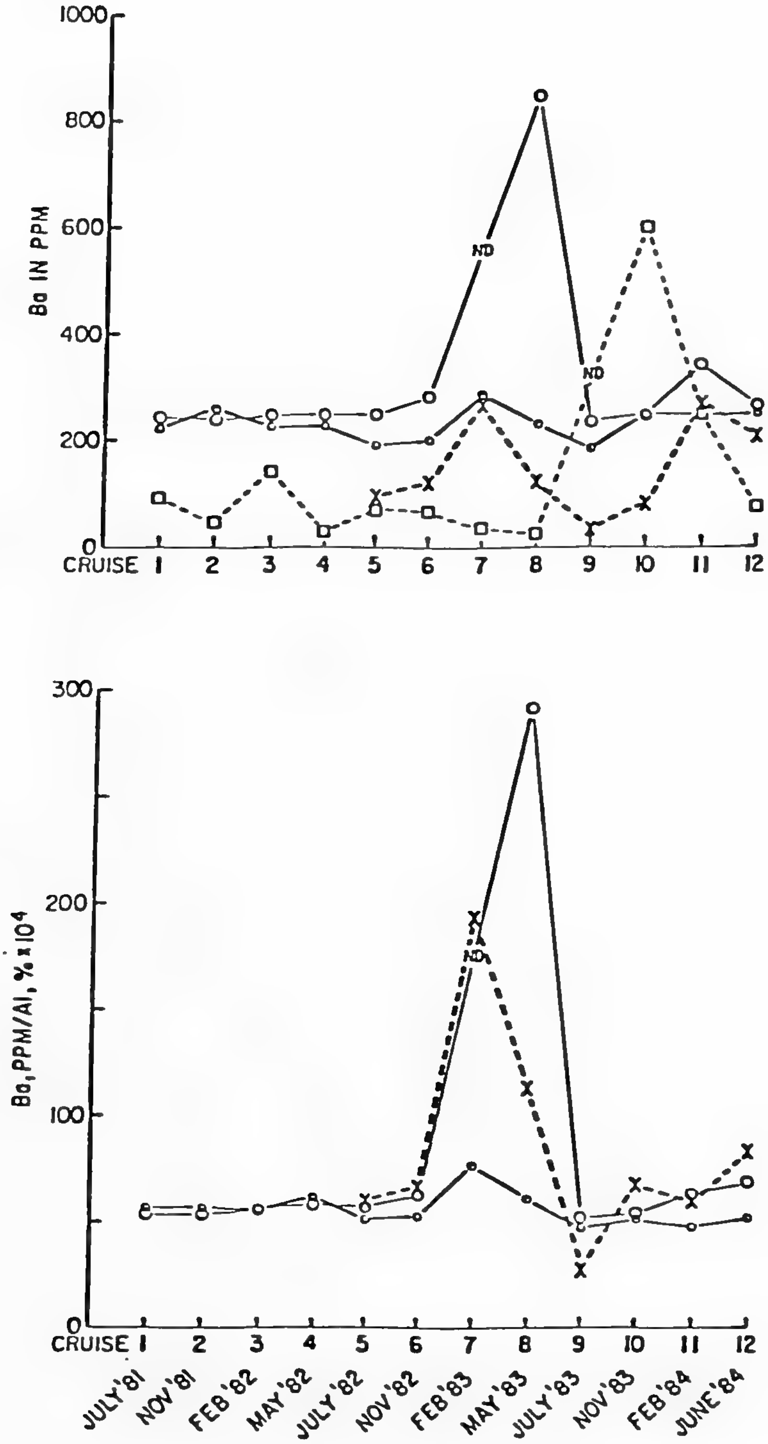

FIGURE 9A and 9B. Concentrations of barium (9A) and the barium to aluminum ratio (9B) in the fine fraction of sediment blends on different sampling occasions at stations 2 (X), 3 (⊙), 10 (□), and 12 (O).

These findings are significant because they suggest that Ba in the finest fraction of drilling mud may be transported over very wide areas of the bank, to the east as well as to the west. Butman and others (1982a) have stated that the mean westerly flow can reverse on the southern flank of Georges Bank in response to strong winds from the southwest. Transport of sediment to stations on transect I from the easternmost drilling locations (blocks 410 and 145) approximately 35 km could have taken place during these eastward current flows. We plan to examine meteorological data and any available current records to determine if a strong easterly current flow occurred sometime prior to cruise 8. It is also possible that the Ba particles carried in the Georges Bank gyre could be transported from drilling locations in a clockwise circular motion to stations 2 and 3.

Trace metals in different size fractions of sediment

As a special study initiated during this program, we used nylon sieves to separate bulk sediment from Georges Bank into various grain-size classes and analyzed the material in each size class for trace metals. We used this approach to determine how those trace metals (notably Ba) whose concentrations are elevated by drilling are distributed within the sediment size fractions. This information may be useful in predicting the transport and dispersion of metals carried by various sediment-size classes.

Based on the textural analyses of standard barite by the American Petroleum Institute, only about 4 percent of the barite used in well drilling is in the 60-150 µm fraction and the remaining 96 percent is finer than 60 µm. Drilling mud is known to adhere to drill cuttings, however, which are often greater than 1,000 µm in size.

Samples were collected on cruises 4 and 10 from the 0-2-cm interval at stations 16 and 5-2 adjacent to drilling sites. To determine the natural

distribution of metals in different size classes, sediment was collected on the same cruises from control station 2.

Figures 10A and 10B show the distribution of sediment in weight percent among various size classes for sediments collected on different cruises at these three locations. For cruise 4, all three stations have similar modes and less than 1 percent silt plus clay. The size distributions are similar on both sampling dates, except that the sample at station 5-2 has modal size in the 500-1,000 μm range for cruise 10 and modal size in the 210-510 μm range for cruise 4.

At control station 2, the Ba inventory among the different size classes (fig. 11A) is distributed in the same pattern as the sediments are distributed (fig. 10A, B). Most of the Ba (more than 80 percent) is contained in the modal size class of 210-500 μm. However, the Ba concentrations of the fine fractions are higher than in the coarser fractions (fig. 11B), and there are only minor differences between samples from cruises 4 and 10 at this location.

The inventory of Ba and the concentration of Ba among the different size classes at station 5-2 are considerably different on cruises 4 and 10 (figs. 12A, B). The concentration of Ba in the finer sediments is much lower on cruise 10 than cruise 4. The differences indicate that while the rig was operating (cruise 4), fine-grained sediments containing high levels of Ba were being deposited (accumulating) in the sediments, and that since drilling has ended, the processes of sediment transport have preferentially removed the fine material. In the time between cruises 4 and 10, the Ba contained in the 30-60 μm fraction decreases from about 50 percent to 10 percent (fig. 12A). The distribution of Ba is bimodal for each cruise, but the distribution changes from one in which the fines are carrying a large Ba inventory as a result of drilling mud accumulation (cruise 4) to one which begins to resemble the distribution of Ba in the uncontaminated sediment (cruise 10).

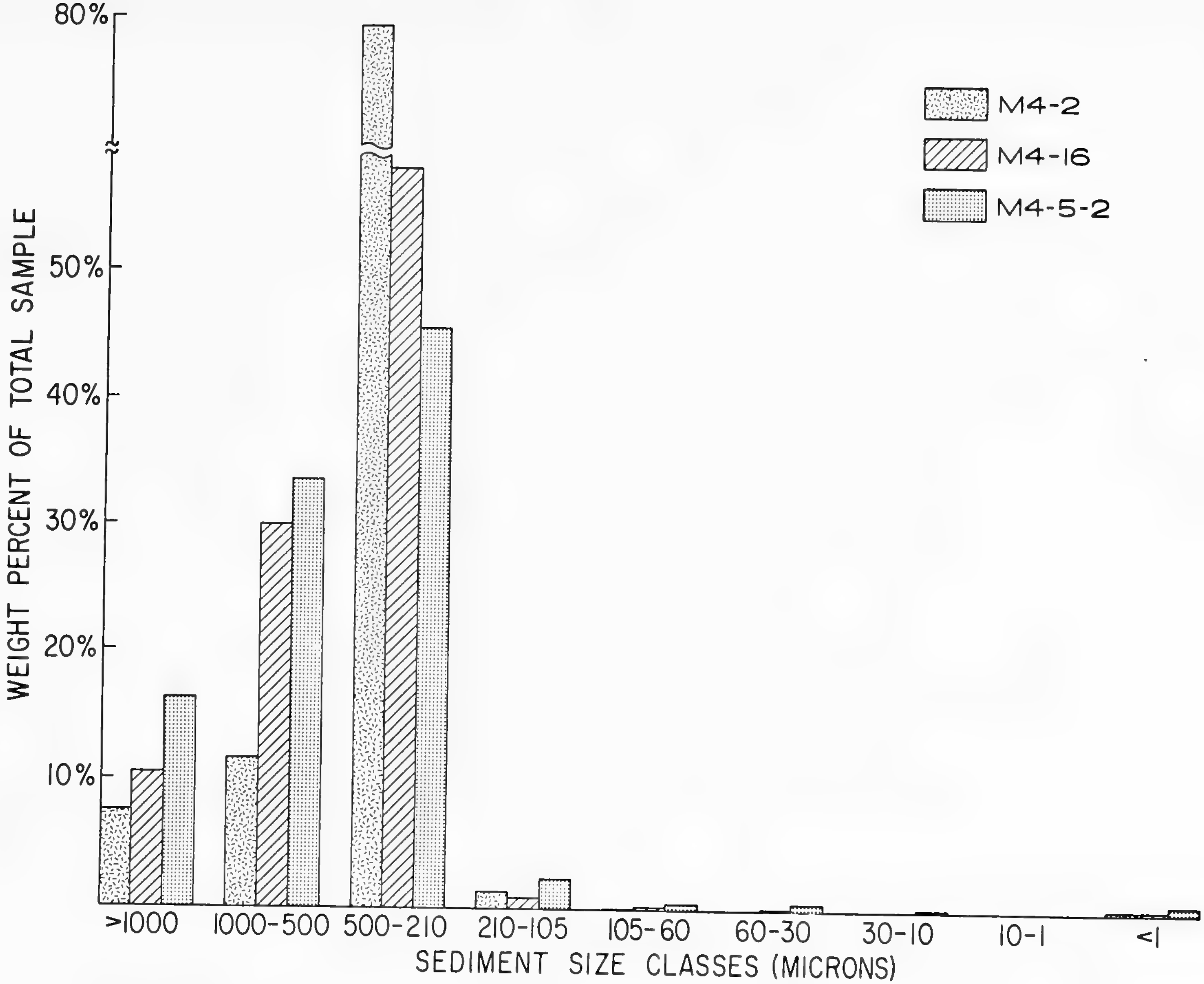

FIGURE 10A. Weight percent of sediment in different size fractions of bottom sediment collected on cruise 4 at control station 2, regional station 16, and site-specific station 5-2 on Georges Bank.

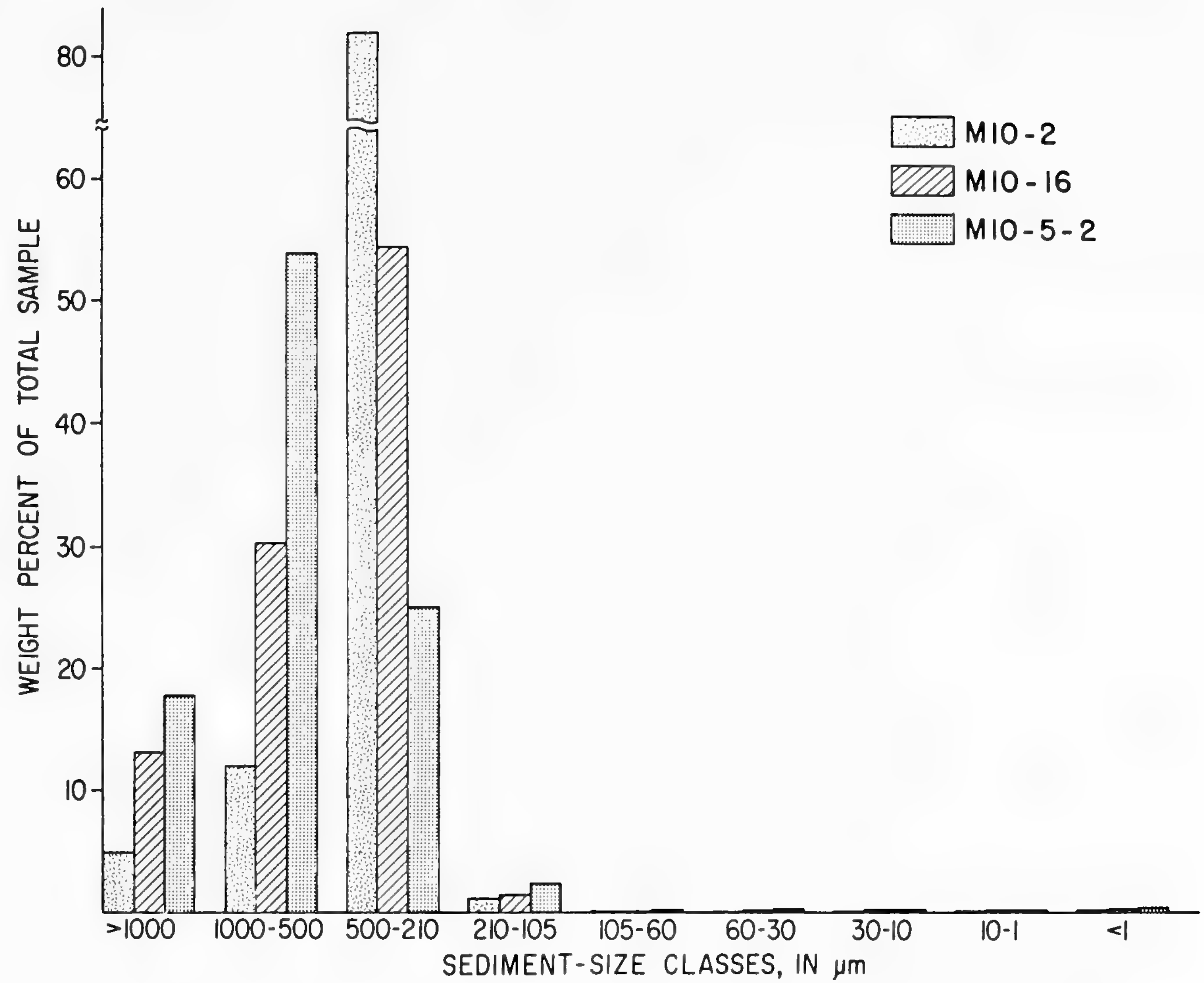

FIGURE 10B. Weight percent of sediment in different size fractions of bottom sediment collected on cruise 10 at control station 2, regional station 16, and site-specific station 5-2 on Georges Bank.

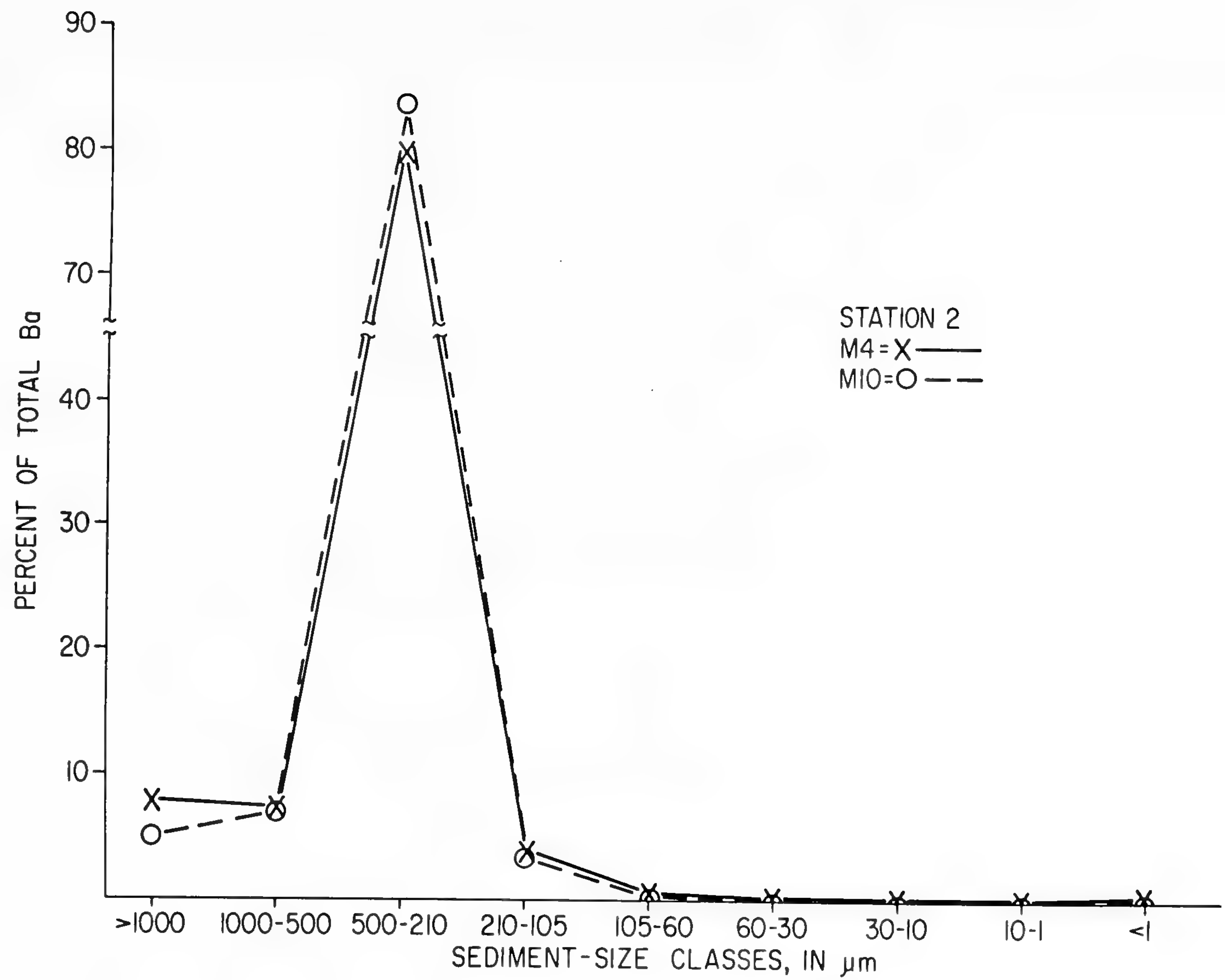

FIGURE 11A. Relative amount (%) of total barium in different size fractions of bottom sediments collected on cruises 4 and 10 at control station 2 on Georges Bank.

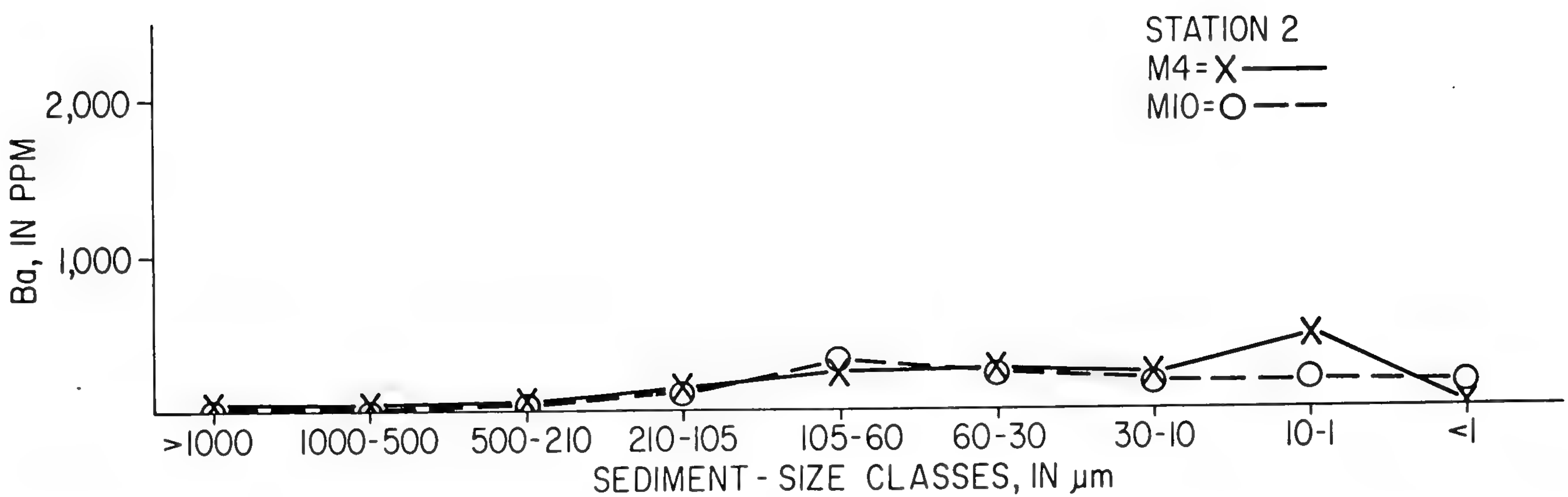

FIGURE 11B. Concentrations of barium in different size fractions of bottom sediments collected on cruises 4 and 10 at control station 2 on Georges Bank.

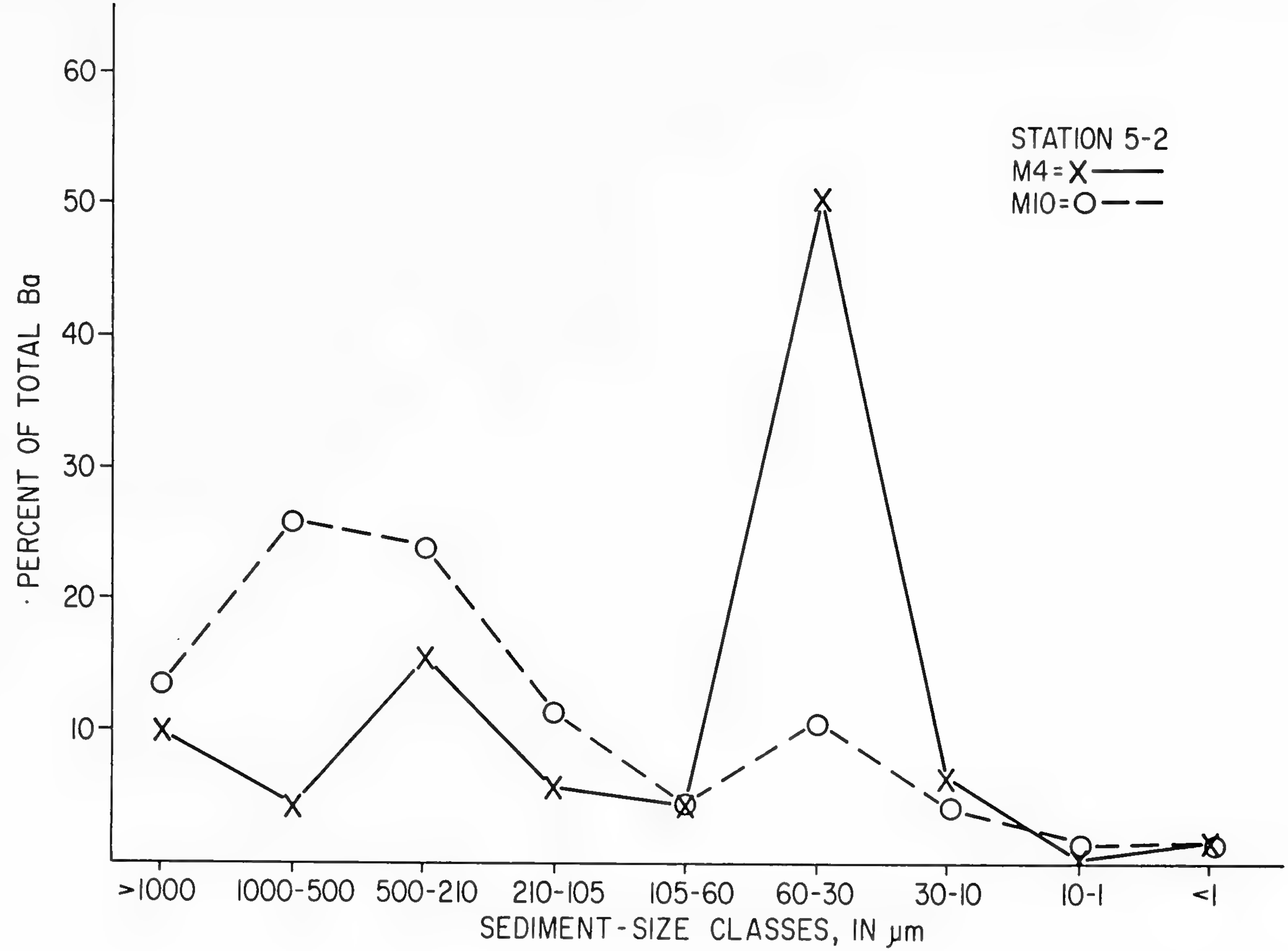

FIGURE 12A. Relative amount (%) of total barium in different size fractions of bottom sediments collected on cruises 4 and 10 at site-specific station 5-2 on Georges Bank.

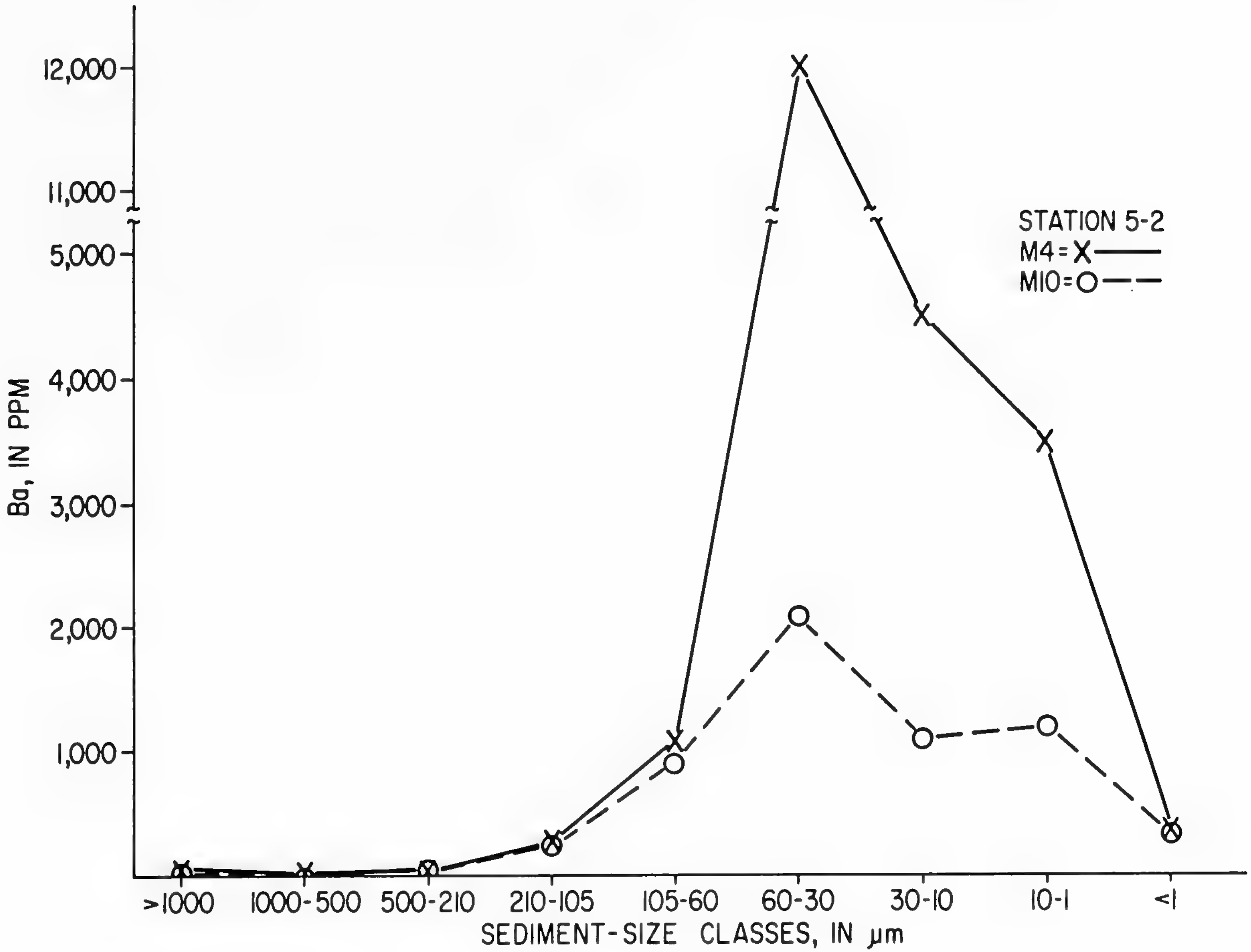

FIGURE 12B. Concentrations of barium in different size fractions of bottom sediments collected on cruises 4 and 10 at site-specific station 5-2 on Georges Bank.

The interpretation of data collected at station 16 is somewhat complicated because the net concentration of Ba in the sample collected during cruise 4 was lower than that collected on cruise 10. The high spatial variability of Ba in sediment adjacent to the drilling rigs has already been discussed. The inventory at station 16 for cruise 4 has a strong peak in the 210-500 μm modal size (fig. 13A), similar to the distribution at control station 2 (fig. 11A), and a small enrichment of Ba in the finer size fractions compared to the uncontaminated control station. At station 16 on cruise 10, we measured a higher total concentration of Ba, with higher concentrations distributed in the finer fraction of cruise 10 than of cruise 4 (fig. 13B). The distribution of the Ba inventory for station 16 on cruise 10 (fig. 13A) is similar to the distribution at station 5-2 on cruise 10 (fig. 12A). We are planning to analyze a third sample from each station collected on cruise 12 and to resample a blend from cruise 4 station 16, if sufficient archived material remains.

Among the other metals analyzed in the size-separated samples (Al, Cd, Cr, Cu, Fe, Mn, Ni, Pb, V, and Zn), only Al and Pb concentrations (and V for cruise 10) in the fractions finer than 30 μm at the drill sites are higher than those at the control station (Bothner and others, 1983; and Appendix table 4C). Concentrations of the remaining metals are distributed similarly at the three stations.

Trace-metal concentrations of sediment-trap samples

The objective of the sediment-trap experiment was to measure the concentration of drilling mud components in suspended matter and to determine if drilling mud was transported to the head of Lydonia Canyon. Sediment traps were deployed at various heights above the sea floor in the vicinity of Block 312 and in Lydonia Canyon (appendix table 1C). This experiment was part of a

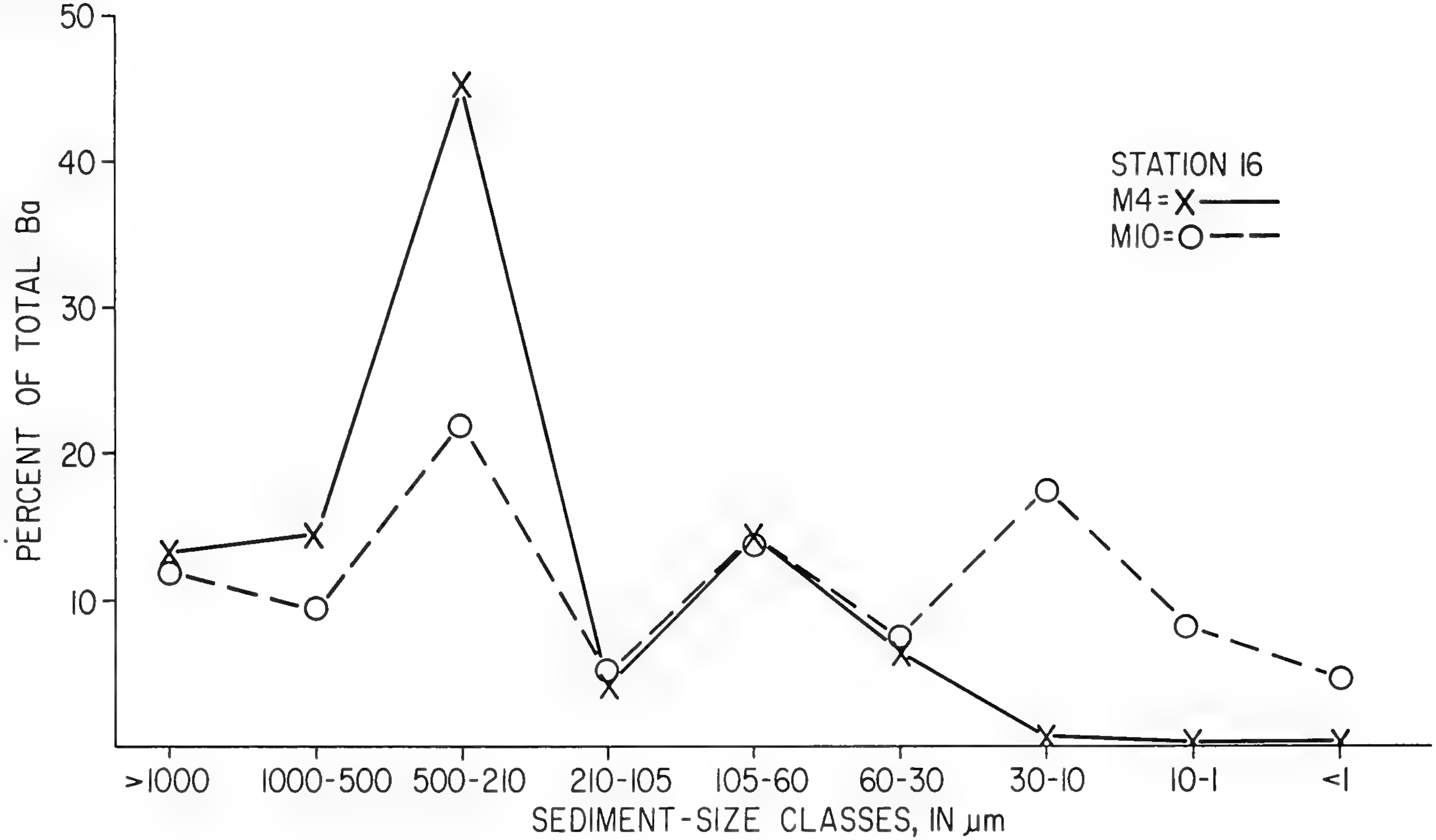

FIGURE 13A. Relative amount (%) of total barium in different size fractions of bottom sediments collected on cruises 4 and 10 at regional station 16 on Georges Bank.

joint USGS and MMS program designed to measure currents and sediment transport on the Continental Shelf and in the major submarine canyons that cut into the southern flank of Georges Bank (Butman and others, 1982b; Butman, 1984). Because the sediment traps used here were no further than 50 m above the bottom and because of the high current velocities at all the mooring locations, the traps primarily collected sediments which were resuspended from the bottom. However, particles falling from surface waters (such as discharged drilling mud), biological material produced in the water column, and particles introduced from the atmosphere also were collected by the traps.

Among the trap samples from locations in the vicinity of block 312, the concentration of Ba is clearly higher in postdrilling samples than in predrilling samples (table 3A, B). The highest concentration of Ba (1,900 ppm) was measured in sediment trap ST424, which was positioned 1 km west of the drill rig in block 312 while drilling was underway. The sediment in this trap was collected in a long tube that was later sectioned into length intervals that represent different time intervals of the deployment. The last material to enter the trap was deposited at the top of the tube. The variation in Ba concentration from interval to interval suggests that the flux of Ba to these traps was not constant. A variable flux is expected because the discharge of Ba was not constant, nor was the current field that transports the drilling mud during and after discharge.

The trap-sample material that was collected at the drill site in block 312 and 1 km to the west of the drill site after drilling was completed contained Ba concentrations five times higher than the predrilling concentrations. The increase in concentration suggests that the barium sulfate deposited in the sediments was periodically resuspended to at least 25 m above the sea floor (the depth of our shallowest trap near the drilling sites) and transported with the prevailing currents.

Sediment traps also were deployed 6 km east of the drilling rig in block 312 while drilling was in progress (ST426) and after completion of drilling in this block (ST513 and ST515). The Ba concentrations of these sediments are also higher than those of predrilling samples. Some of the material contributing to the elevated Ba concentrations measured in these samples may have originated from the four drilling rigs operating between 5 and 45 km to the south or east of these trap locations. Alternatively, storm and tidal currents could have transported material eastward.

There is a weak but positive indication that drilling mud was transported in measurable concentrations to the expected depositional site at the head of Lydonia Canyon (fig. 14, table 3C). Drilling began during the second period in which sediment traps were used to collect suspended sediment (fig. 14). The concentration of Ba in the fine fraction of trap sediments from the head of Lydonia Canyon increases slightly from the first deployment until the fourth deployment and then appears to increase more dramatically at the time of the fifth deployment, which includes the period when four wells were finishing drilling activity on the bank (fig. 14). On the basis of these increases in Ba concentration, which were measured in traps at two levels in the water column (10 m and 20 m above bottom), we suggest that a small drilling mud signal was present in the suspended matter in Lydonia Canyon. No such indication is apparent from the analysis of the bulk sediment-trap material--for which the Ba concentrations during the period of drilling are generally within one standard deviation of the concentrations determined in predrilling trap samples (table 3A, B).

Trace-metal variations with depth in sediment

During the second and third year of monitoring, sediment cores and grab samples (appendix table 4D, and Bothner and others, 1983) were subsampled as a

Table 3A. - Chemical analyses of sediment-trap samples collected before drilling began (Bothner and others, 1982)

	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Hg (ppm)	Fe (%)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)
Mean-------------------	3.04	225	0.26	71	19	0.044	1.94	466	39	36	82	132
Stand. dev.-------------	.79	66	.28	15	10	.009	.40	130	15	10	28	124
No. of analyses---------	13	13	2	13	13	13	10	13	13	12	13	13

Table 3B. - Chemical analyses of sediment-trap samples collected after drilling began (Bothner and others, 1982)

Field no.	Lab no.	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Hg (ppm)	Fe (%)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)
Lydonia Canyon: drilling in progress													
ST222-0-15[1]---	W-221248	3.91	304.2	0.08	52.1	10.9	0.05	2.50	348	31.5	32.6	66.3	65.2
ST301-0-4------	W-221249	3.78	266.5	.05	47.7	17.8	.04	2.33	444	27.8	33.3	53.3	64.4
ST403-0-20----	W-221285	3.20	260.0	.09	40.0	14.0	.03	1.90	240	18.0	26.0	44.0	46.0
ST536-0-2------	W-221271	3.54	274.2	.16	45.7	16.0	.03	2.06	366	17.1	28.6	41.1	62.8
1 km west of rig: drilling in progress													
ST424-0-4------	W-221251	2.73	1783.6	.39	40.4	11.7	.04	2.14	345	14.3	34.5	42.8	89.2
ST424-4-7------	W-221252	2.52	1889.1	.38	37.8	8.9	.03	2.14	290	12.6	30.2	45.3	74.3
ST424-7-10-----	W-221253	2.98	1152.9	.45	40.9	9.4	.04	2.36	310	16.1	27.3	54.5	62.0
ST424-10-15----	W-221254	3.11	771.8	.18	40.3	11.1	.03	2.30	357	12.7	30.0	55.3	57.6
ST424-15-17----	W-221255	3.34	1224.5	.17	44.5	13.6	.03	2.60	445	18.6	39.6	59.4	73.0
ST424-17-20.5-	W-221256	3.40	551.7	.22	51.7	16.4	.03	2.70	481	17.6	64.6	69.3	89.2
6 km east of rig: drilling in progress													
ST426-0-4------	W-221257	2.24	407.0	.51	27.5	10.2	.02	1.73	275	11.2	25.4	34.6	76.3
ST426-6-8------	W-221258	3.09	482.4	.35	44.5	11.1	.04	2.47	346	13.6	30.9	56.9	56.9
ST426-12.5-15-	W-221259	3.07	378.1	.45	40.2	11.8	.03	2.48	449	15.4	36.6	59.1	100.4
Rig site: postdrilling													
ST501C-W[2]------	W-221260	2.96	1023.5	1.08	24.2	24.2	.04	2.10	253	5.4	18.3	5.4	121.2
ST502-0-4------	W-221261	3.24	802.7	.30	44.0	23.3	.05	2.46	867	24.6	46.6	62.1	79.0
ST502-4-8------	W-221262	3.48	721.7	.55	43.8	20.6	.10	2.58	760	23.2	46.4	61.9	86.3
ST502-8-12-----	W-221263	3.42	756.7	.41	43.9	19.5	.07	2.56	622	22.0	43.9	61.0	74.5
ST502-12-14----	W-221264	3.18	1070.5	.42	40.0	14.1	.04	2.35	459	15.3	31.8	56.5	69.4
ST505C-W-------	W-221265	3.49	1070.9	.14	49.8	18.7	.03	2.61	237	27.4	43.6	71.0	72.2
1 km west of rig: postdrilling													
ST506C-W-------	W-221266	2.30	767.4	.73	26.9	13.6	.03	1.71	230	3.8	30.7	11.5	211.0
ST508C-W-------	W-221267	3.47	1165.3	.21	48.3	19.8	.04	2.60	198	24.8	44.6	64.5	74.4
ST510C-W-------	W-221268	1.98	796.0	.03	26.1	10.4	.02	1.46	250	10.4	26.1	23.0	55.3
6 km east of rig: postdrilling													
ST513C-W-------	W-221269	3.28	625.8	.14	43.2	12.4	.04	2.38	328	11.2	37.2	41.7	76.0
ST515C-W-------	W-221270	3.28	702.0	.11	45.2	15.8	.03	2.37	226	21.5	33.9	66.7	79.2

[1]Depth interval (cm) in sediment-trap sample.
[2]W-whole sediment trap homogenized before analysis.

Table 3C. - Chemical analyses of sediment-trap samples.

<60 µm

Field no.	Lab no.	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Hg (ppm)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)
ST103-18-23X	W-226325	4.80	270	0.130	62.0	22.0	3.10	.06	590.	48.0	39.0	97.0	120.0
ST222-15-20X	W-226326	4.50	280	.300	58.0	23.0	2.70	.00	350.	43.0	32.0	89.0	110.0
ST301-02-08X	W-226327	4.80	290	.150	64.0	28.0	3.10	.04	570.	49.0	37.0	100.0	110.0
ST403-00-03X	W-226328	4.50	300	.310	190.0	22.0	2.70	.06	290.	48.0	25.0	100.0	110.0
ST536-02-04X	W-226330	4.80	350	.170	69.0	22.0	3.20	.04	520.	51.0	312.0	100.0	110.0
ST537X	W-226331	4.80	380	.280	63.0	34.0	3.20	.04	430.	53.0	33.0	100.0	120.0

>60 µm

Field no.	Lab no.	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Hg (ppm)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)
ST103-18-23Y	W-226333	2.80	240	0.110	44.0	11.0	1.70	.04	310	19.0	17.0	31.0	48.0
ST222-15-20Y	W-226334	3.60	250	.320	49.0	17.0	2.40	.03	270	30.0	25.0	62.0	100.0
ST301-02-08Y	W-226335	2.90	270	.055	33.0	13.0	1.50	.02	250	15.0	16.0	34.0	43.0
ST403-00-03Y	W-226336	2.60	260	.050	760.0	6.0	1.50	.01	200	34.0	13.0	34.0	68.0
ST536-02-04Y	W-226338	2.90	270	.096	36.0	11.0	1.60	.03	250	18.0	16.0	31.0	50.0
ST537Y	W-226339	2.80	260	.150	33.0	14.0	1.60	.03	280	16.0	15.0	34.0	48.0

<60 µm (X) and >60 µm (Y)

Field no.	Lab no.	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Hg (ppm)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)
ST424-00-04X	W-226329	3.60	1500	.600	51.0	14.0	2.90	.04	390	33.0	31.0	74.0	170.0
ST424-00-04Y	W-226337	2.10	870	.380	31.0	10.0	1.50	.03	240	10.0	15.0	31.0	91.0
ST001-00-08X	W-226332	3.60	190	.250	54.0	17.0	3.20	.04	350	36.0	30.0	78.0	88.0
ST001-00-08Y	W-226340	3.00	230	.120	42.0	13.0	2.50	.02	310	24.0	24.0	62.0	55.0

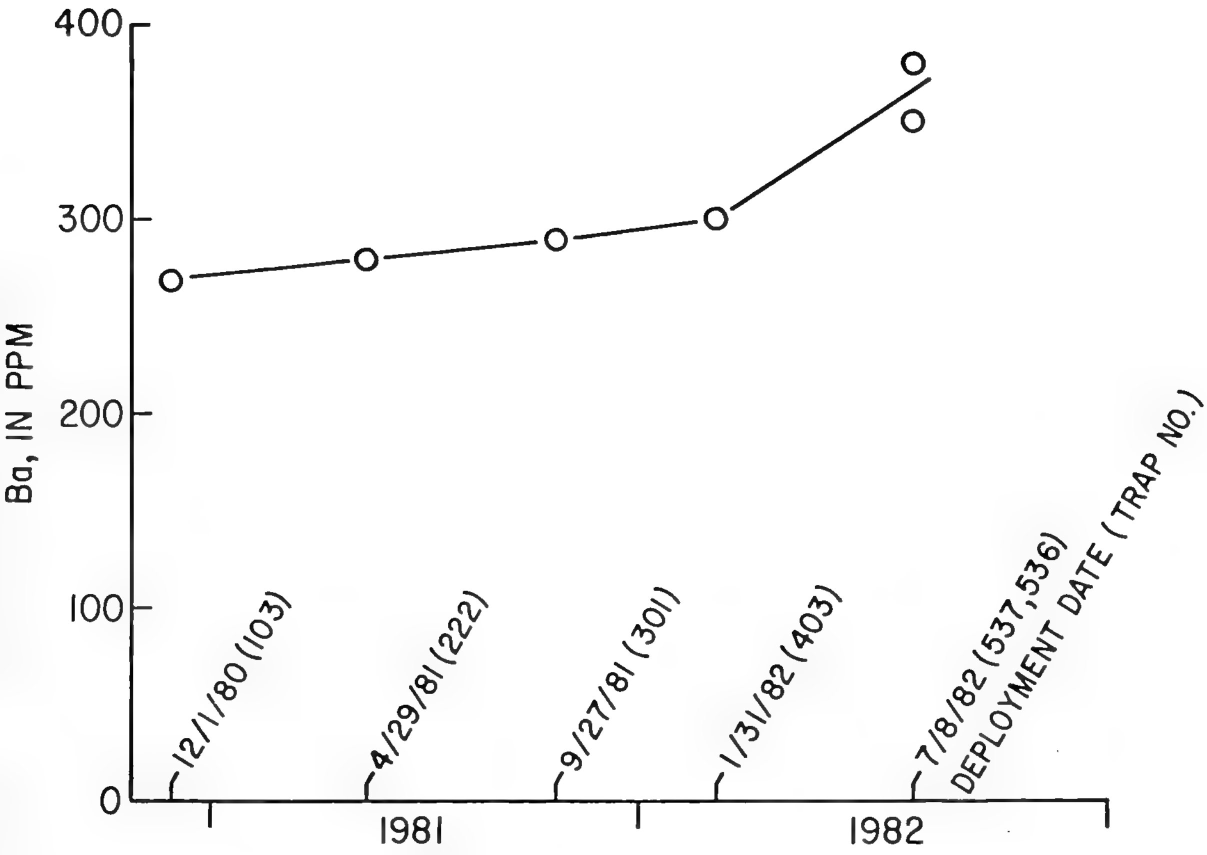

Figure 14. Concentrations of barium in the fine fraction of material collected in sediment traps deployed at the head of Lydonia Canyon on different deployment dates. Traps were recovered just prior to the next deployment.

function of sediment depth to determine the depth profiles of metal concentrations. A gradient in the depth profile of a metal concentration can indicate the introduction or removal of the metal. Our first objective was to extend our search for drilling-related Ba to locations on the bank where data from seasonal cruises may not be available. Second, we hoped to make some inferences about the extent and rate of downward mixing of newly introduced Ba by benthic organisms and/or currents by examining profiles at stations adjacent to drilling operations.

We examined the profiles of Ba and Ba/Al in four areas where the introduction of drilling mud was not expected (fig. 15A-D, location of samples shown in fig. 1). Although there is some scatter in the Ba values, particularly in sample M11-03-00-AX, the Ba/Al ratio is constant with depth at all four locations. This is a particularly important observation because it argues against the possibility that the naturally occurring Ba dissolves in response to reducing conditions in subsurface sediments and migrates upward into oxidizing sediments, where it precipitates. Sufficient reducing conditions in the sediments for the characteristic migration and precipitation of Mn has been observed in the interstitial water of core 83G9-B (K. O. Buesseler and E. R. Sholkovitz, Woods Hole Oceanographic Institution, pers. commun., July 1984) as well as in the total sediment phase (appendix table 4D). The absence of a gradient in Ba or Ba/Al at all four locations, which represent different sediment types, suggests that the gradients measured closer to drilling sites are not due to diagenetic reactions.

An additional point regarding core 83G9-B, from 1,250 m water depth on the slope, is that concentrations of Pb are higher in the surficial sediment than in subsurface sediment (appendix table 4D). The source of this Pb is probably the burning of lead alkyls in gasoline in coastal metropolitan areas,

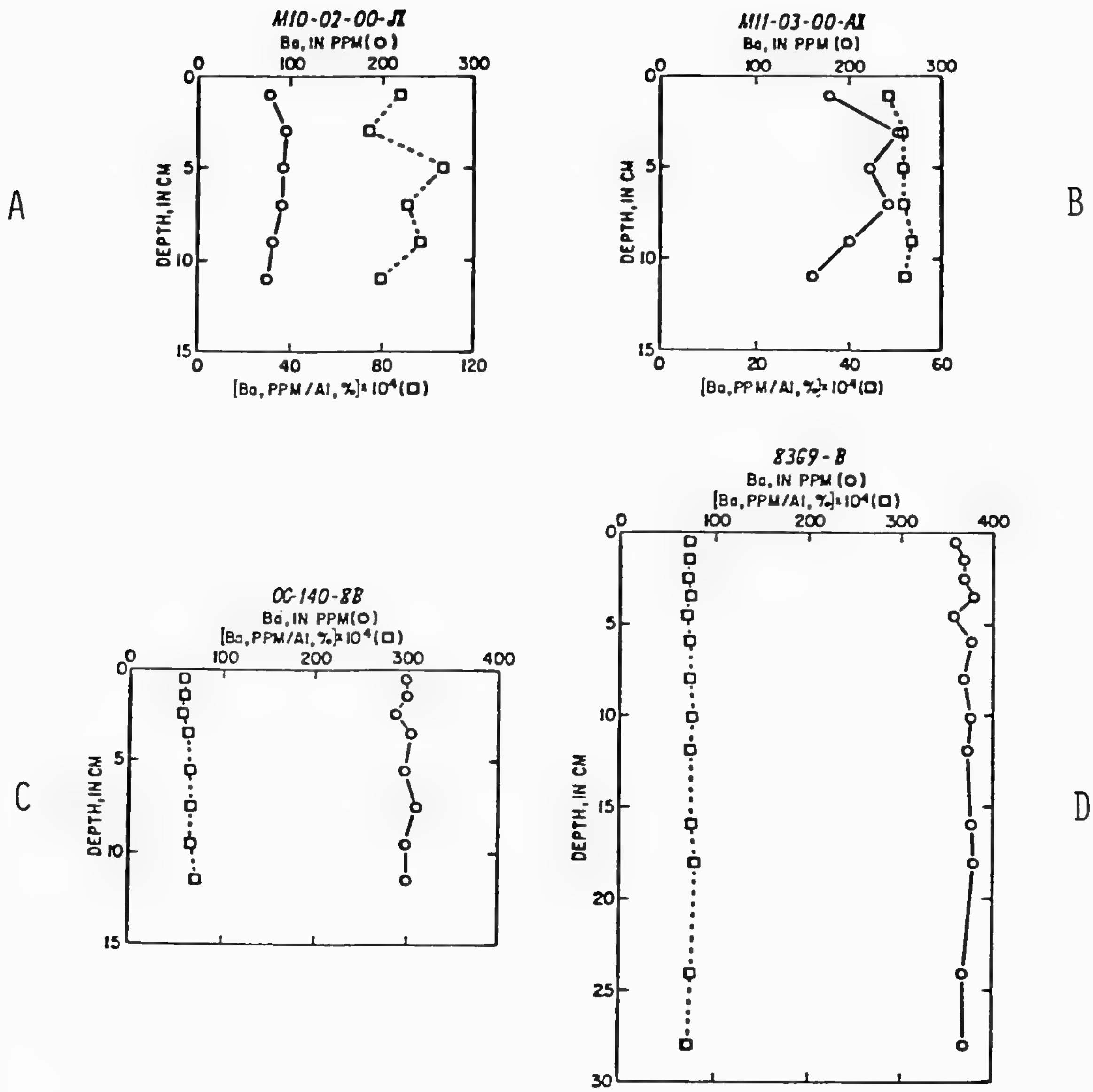

FIGURE 15 A-D. Distributions of barium and the barium to aluminum ratio with sediment depth. Analyses were performed on the fine fraction of sediment. Stations 2 and 3 were sampled with a grab sampler. Samples OC140-8B and 83G9-3 were collected with a hydraulically damped gravity corer and a box corer, respectively.

which began in 1924 and which has dramatically increased each year since 1940 until the recent switch to unleaded gasoline. Atmospheric transport of Pb with the prevailing westerly winds would move Pb to surface waters in this general location. A similar profile of lead was observed in sediments from the Mud Patch collected before drilling began (Bothner and others, 1981).

We also analyzed sediment profiles from locations west of the drilling activity where deposition of transported drilling mud was expected. Both Ba and Ba/Al at station M10-12-00-GX are slightly enriched in the surface 8 cm compared to the deeper section of the core (fig. 16C). This supports the conclusion that Ba has been transported to this station, as discussed earlier using the data presented in figure 9A, B. At locations OC140-39 and OC140-41 to the east of transect III (fig. 1), the Ba concentrations in fine fraction samples of the upper 5 cm are not elevated above the deeper sections in the sediments, but there is a slight enhancement in the Ba/Al ratio in the surface sediment (fig. 16A, B) that is statistically significant at the 99.9 percent level of confidence (t test). At stations M12-19 and M12-21, there are small increases in the Ba/Al ratio in the surficial sediment, but no increase in the Ba concentration (fig. 16D, F). Profile M12-20 shows no increase in either Ba or Ba/Al (fig. 16E). At stations 19, 20, and 21, an increase in both Ba and Ba/Al in the surface sediments was measured at the time of cruise 9 (reported in Bothner and others, 1983).

The Ba and Ba/Al profiles at stations M12-05 and M12-16, adjacent to drilling locations in blocks 312 and 410, respectively, show much higher concentrations than at any of the other more distant stations (fig. 17A, B). These profiles illustrate two points. First, fine-grained Ba-rich particles have penetrated to at least 15 cm depth since the drilling began at these

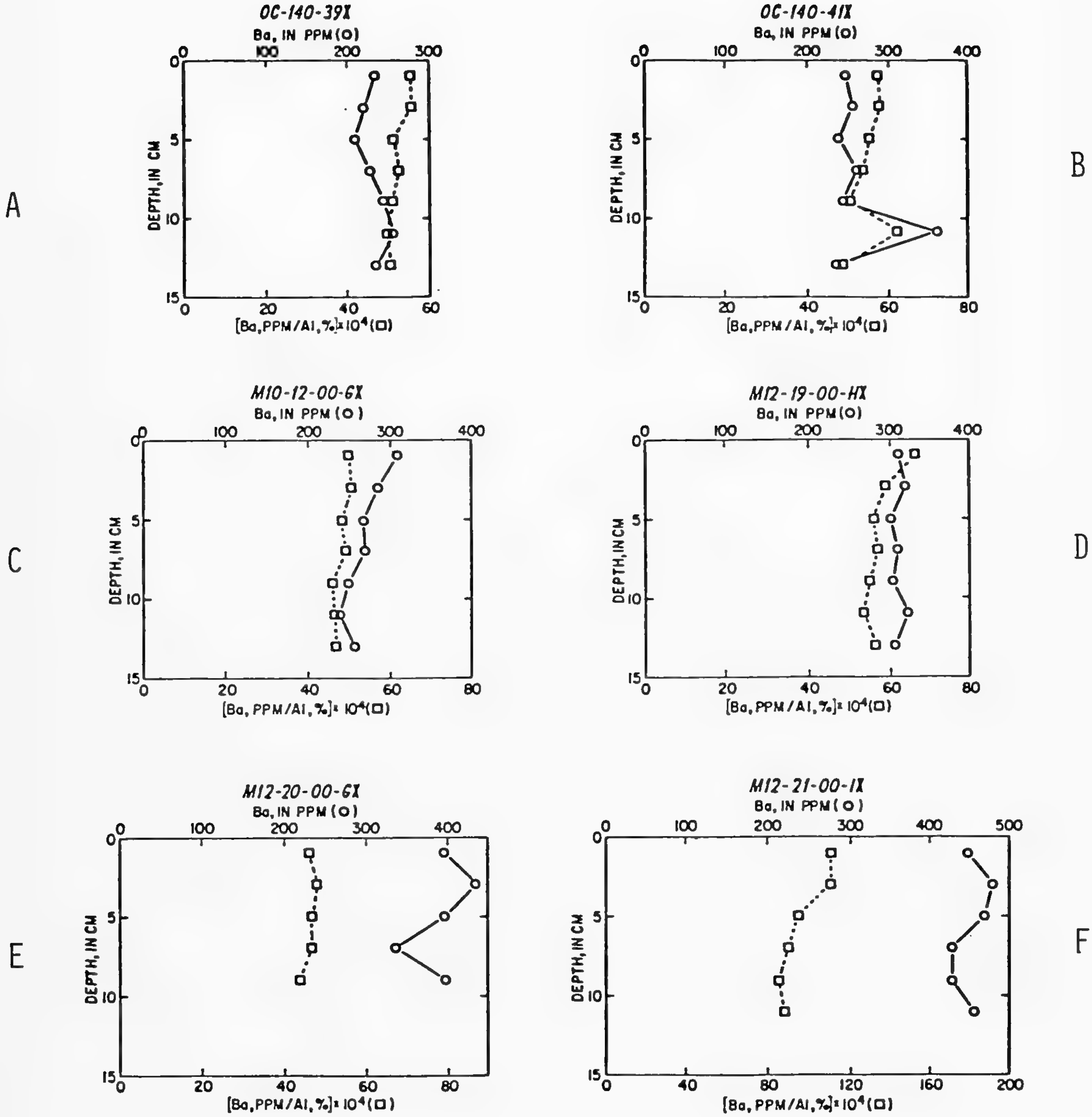

FIGURE 16 A-F. Distributions of barium and the barium to aluminum ratio with sediment depth. Analyses were performed on the fine fraction of sediment. Samples were collected with a grab sampler.

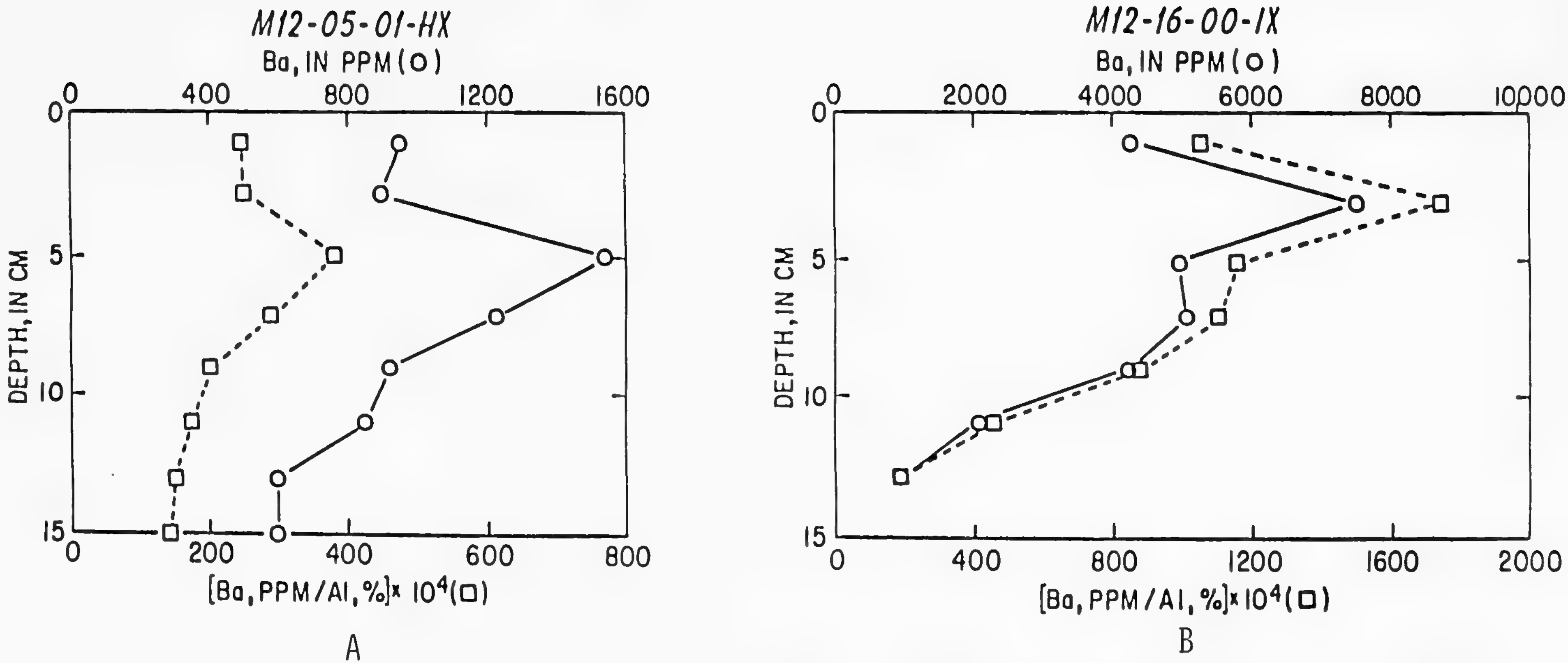

FIGURE 17A and 17B. Distributions of barium and the barium to aluminum ratio with sediment depth. Analyses were performed on the fine fraction of sediment. Samples were collected with a grab sampler.

locations. Second, the subsurface maximum in concentration suggests either that new sediments, having a lower Ba concentration, have accumulated on top of the drilling mud components or that new sediments have been exchanged (no net accumulation) for the drilling mud components by a combination of sedimentation, sediment mixing, and erosion.

A future follow-up of this study should be undertaken to determine the Ba concentration and the Ba/Al ratio in profiles using the bulk sample. Comparison of profiles of the bulk sample and the fine fraction is necessary to determine the amount of Ba which is missed by the standard field sampling technique of collecting the upper 2 cm of sediment. In addition, longer core samples (30-40 cm) should be taken at the drill sites to carefully determine whether the decrease in Ba concentration in the surface sediment is due to actual removal or to downward mixing.

Barium inventory and decrease at block 312

The high density of stations and the frequent sampling at the drill site in block 312 present the opportunity to estimate the inventory of barium in the sediments before, during, and after drilling. One objective of this exercise is to determine how much of the Ba actually discharged by the drilling rig was deposited within 6 km of the drill site at the time of well completion. Of particular interest is an estimation of the rate at which Ba concentrations decreased in the surface sediments after drilling was completed. The barium added by the drilling can be considered to be a tracer for sediment transport processes. Although barium sulfate has a greater density than the average sediment on the bank, the rates of removal determined for barium may provide some insight into the fate of future contaminants that reach the sediments on Georges Bank.

To determine the inventories of Ba within the 6-km-radius circle (fig. 1B), the Ba concentrations on each ring of the sample pattern were averaged and used to estimate a representative concentration for each annulus around the drill site. We assume that the Ba added by the introduction of drilling mud is contained within the sampling depth interval of 0 to 2 cm. This is a valid assumption until at least cruise 5, based on core profiles from station 5-1 reported in the second year final report. For comparison to the amount of $BaSO_4$ used in the drilling operation, we have converted both predrilling and postdrilling Ba concentrations to $BaSO_4$. The inventory of barite is calculated from the field data with the following relation:

$$\text{Total}=\sum A\cdot d\cdot Z\cdot C\cdot(BaSO_4/Ba)$$

where A=area of each annulus, d=bulk density of dry sediment (1.6 g/cc), Z=depth interval (0-2 cm), C=concentration of Ba (µg/g), and $BaSO_4/Ba$ is the ratio of molecular weights.

We estimate that the inventory of $BaSO_4$ in the upper 2 cm of sediment in the 6 km circle totals 0.59×10^6 to 0.62×10^6 lb before drilling began (cruises 1 and 2). The inventory increases to 0.86×10^6 lb on cruise 5 just after drilling stops (net increase of 0.27×10^6 lb) and decreases to values between 0.68×10^6 and 0.60×10^6 lb for the last four cruises (fig. 18).

The total barium sulfate used in drilling the exploratory well at block 312 was 2,387,800 lb (Danenberger, 1983). An estimated 630,000 lb was left in the hole when the rig moved off location. If there were no losses of mud to porous subsurface rock formations while drilling, which is highly unlikely, then the total barite discharged to the ocean was 1,757,800 lb. This estimate is considered an upper limit because some loss to porous formations is expected. E. P. Danenberger (Minerals Management Service, oral commun., September 21, 1983) estimated that, on the basis of drilling records,

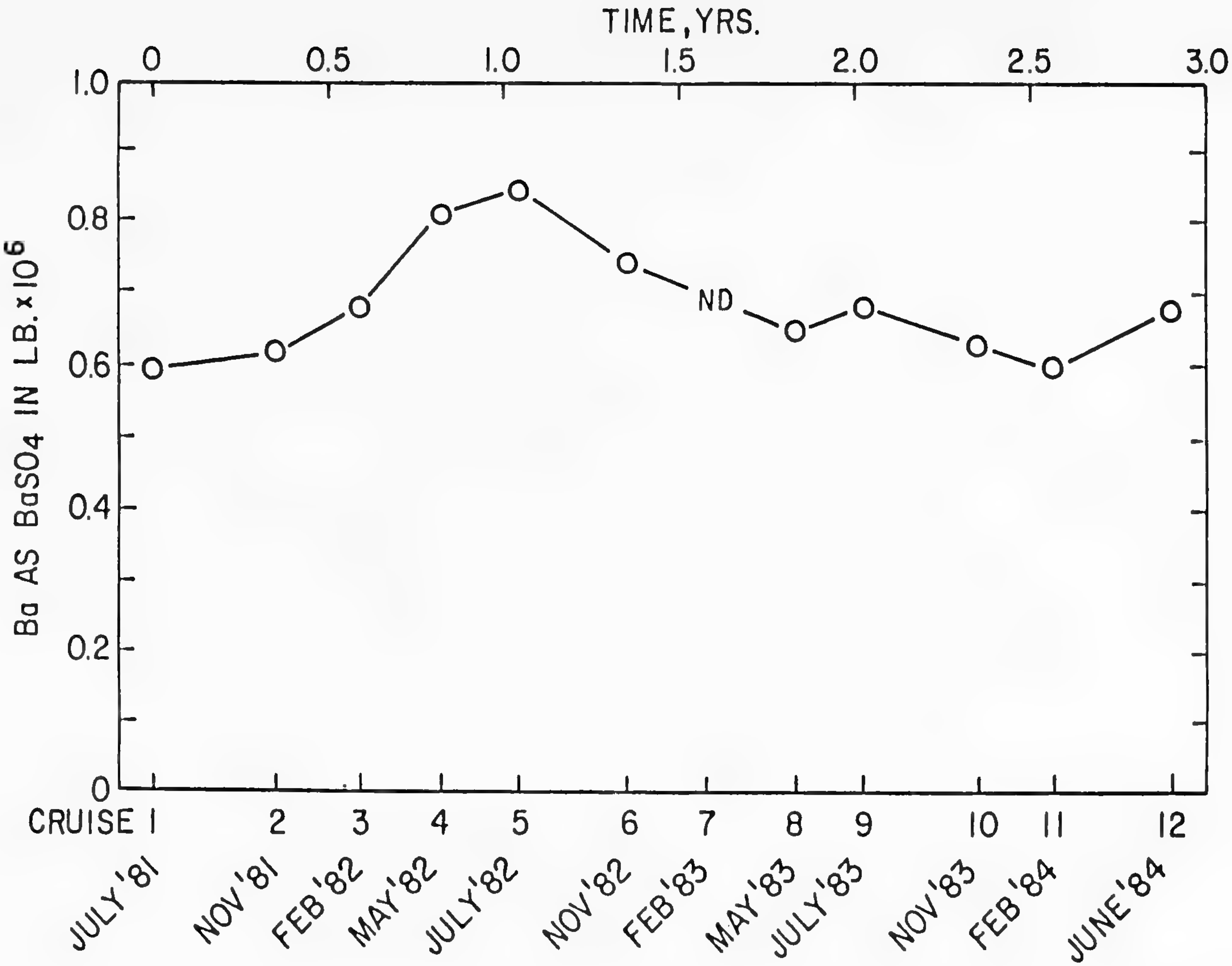

FIGURE 18. Total inventory of barite (calculated from barium concentrations) within the 6 km radius around station 5 on different sampling occasions. ND=no data.

the maximum losses to porous formations would reduce the barite discharge to 800,000 lb. Danenberger suggested that the most likely range of barite discharge is between 1 million and 1.5 million lb. We will assume the mid value of this range, 1,250,000 lb, for the total barite discharged to the ocean while drilling this well.

The net mass of barite added by drilling within the 6 km circle at the time of cruise 5 represents 25 percent of the total amount discharged (270,000/(1,250,000*(0.85))(100). The factor 0.85 represents the fraction of pure $BaSO_4$ contained in mined barite.

In our evaluation of the rate at which barite decreases within the site-specific survey, we have considered only the area between the 0.5 and 2 km ring. This choice includes 20 of the 29 stations and avoids the area of the outer two rings where half of the total area is controlled by as few as four stations. We have also excluded the actual drill site, where large within-station variability was measured. Another advantage in considering this smaller area is that data on Ba in the fine fraction are available from most of these 20 stations, which permits an additional rate calculation. The changes in inventory of Ba as $BaSO_4$ in the 0.5-2 km area are shown in figure 19.

For cruise 5, we assigned a value of 1 to the net barite inventory (total barite-background barite) for the 0.5 to 2 km area and calculated the net barite for each successive cruise relative to cruise 5. A semi-log plot of the data appears to have two relatively straight line segments (fig. 20), which approximates the mathematical model for radioactive decay for two isotopes having different half-lives. If one uses this model and least squares regression to describe the removal of barite from the surface sediments, the initial "half-life" or half-time of barite within this area of the site-specific survey is 0.34 years (cruises 5, 6, and 8, r=-.99).

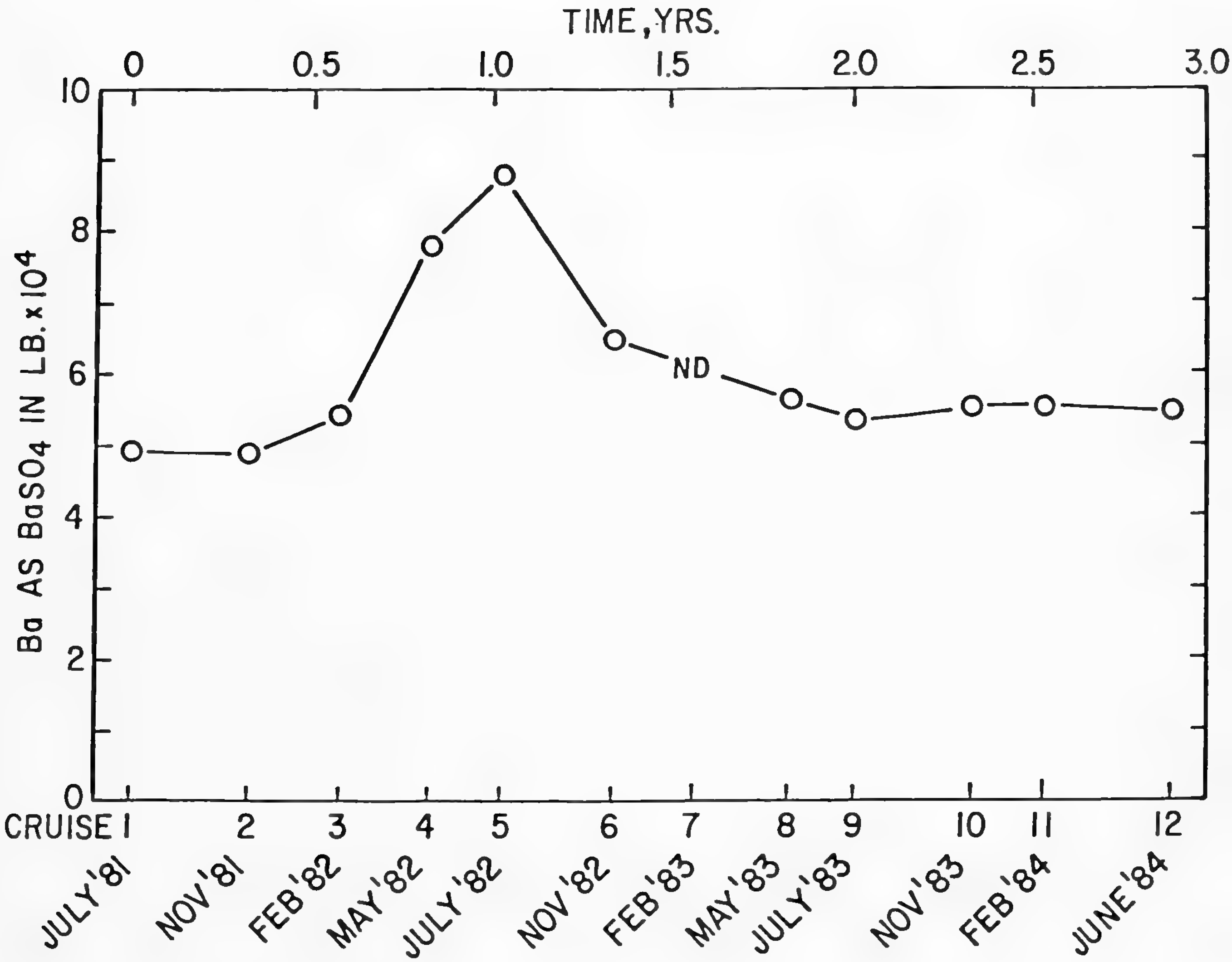

FIGURE 19. Total inventory of barite (calculated from barium concentrations) within the 0.5-2 km annulus around station 5 on different sampling occasions. ND=no data.

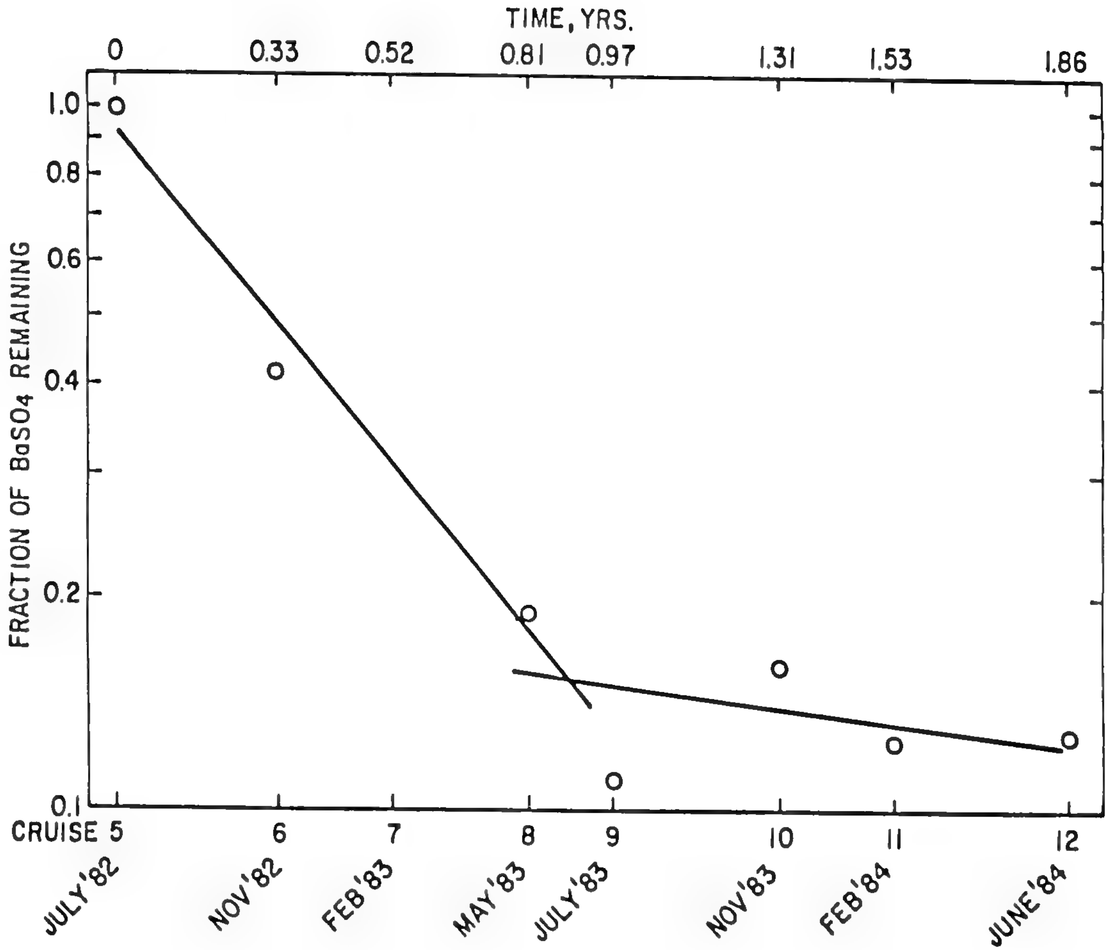

FIGURE 20. Decrease of the net barite inventory within the 0.5-2 km annulus around station 5 with time. Values are based on analyses of the bulk sediments. Fraction remaining is relative to the amount present at the time of cruise 5, 4 weeks after drilling was completed.

A second slower rate is more arbitrarily defined by the data at the end of the monitoring program. The linear regression of cruises 8-12 gives a half life of 3.4 years (r=-.40) as shown in figure 20, but cruises 9-12 did not predict a decrease with time. The average inventory of barite between 0.5-2 km from the drill site during cruises 9-12 is 5.5±0.1 ($x10^4$) lb. This value is 12 percent higher than the average predrilling inventory of 4.9±0.1 ($x10^4$) lb calculated for cruises 1 and 2 (fig. 19). The total inventory (fig. 19) should be monitored again at annual intervals to determine the slower rate of removal.

A similar calculation of the change in net barite inventory of the fine fraction (fig. 21) yields a rapid initial half-time of 0.25 years. The secondary rate after cruise 8 appears much slower, or zero; there are insufficient data for an estimate.

This model is certainly oversimplified, but retains some merit. One basic assumption of this exponential decay model is that each particle has the same probability of escaping. In this case, the mechanism of escape is thought to be suspended or bed-load transport away from the drill rig or downward mixing and exchange with uncontaminated sediments below. Although larger barite particles generally would have a lower probability of eroding than finer particles, there are relatively few barite particles large enough to resist sediment transport by resuspension. Bottom stresses on Georges Bank are frequently greater than 1.7 dynes/cm^2, the stress required to resuspend barite particles 63 µm in diameter (Butman and Moody, 1983). Since about 96 percent of the barite used in drilling is finer than this size, we assume that most of the whole size range of barite particles will be moved frequently by resuspension. Therefore, we attribute the initial rapid rate of Ba removal to the effects of resuspension and transport within the water column.

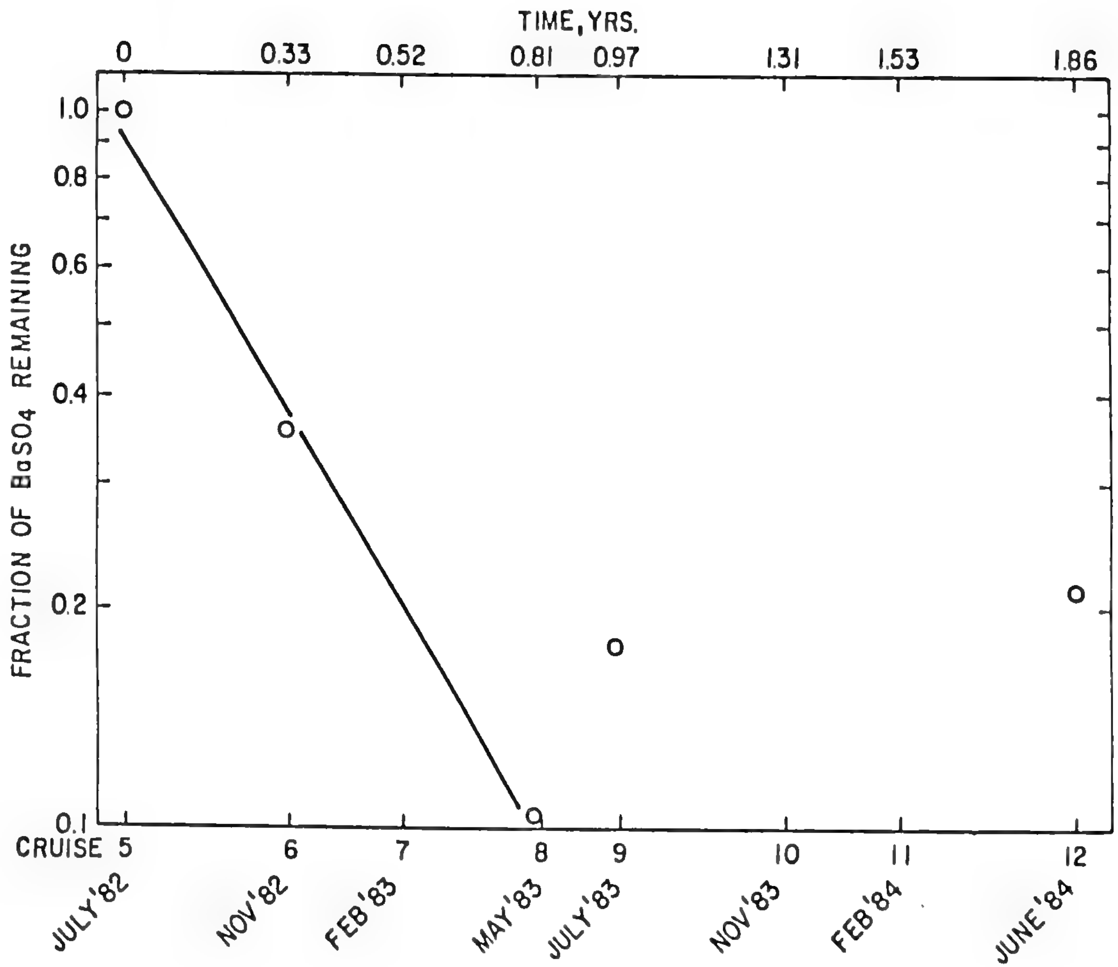

FIGURE 21. Decrease of the net barite inventory within the 0.5-2 km annulus around station 5 with time. Values are based on analyses of the fine fractions of sediments. Fraction remaining is relative to the amount present at the time of cruise 5, 4 weeks after drilling was completed.

The slower rate of barite disappearance from the upper 2 cm measured after cruise 8 is probably related to the effect of downward mixing into the sediment. This process decreases the concentration in the surface 0 to 2-cm layer by dilution rather than actual removal. Consequently, the removal process is actually slowed by mixing processes since larger storms (which are less frequent) are necessary to erode sediments to the increasing depths of Ba penetration.

The slower rate of barite disappearance after cruise 8 could also be caused by the accumulation of sediments having lower Ba concentration on top of the sediments having higher Ba concentrations. Although Georges Bank as a whole is considered to be eroding, processes of sediment redistribution and local accumulation have been identified (Twichell, 1983).

What is the fate of the barite which is discharged by drilling operations and subsequently eroded from the sediments near the drill rigs? Some of the barite may dissolve into seawater which is undersaturated with respect to $BaSO_4$ (Chow, 1976; Dehairs and others, 1980). However, the rate of dissolution is likely to be slow and the Ba released by dissolution may be reprecipitated by certain planktonic organisms or during the decomposition of suspended-organic matter (Dehairs and others, 1980).

The fate of Ba added to Georges Bank seems, at present, to be linked to sediment transport processes. We have found small Ba increases in the fine fraction of sediment at distant stations both to the west and to the east of the drilling area. To the west at station 12, we have found Ba concentrations in the surface sediment higher than in sediment at greater depth. At both stations 10 and 12, we have observed peaks in the Ba concentration of postdrilling samples. At coring stations 50 km west of transect III (OC140-39, 41), we observed an enrichment of the Ba/Al ratio in surface sediments and

interpret this as evidence for a small recent addition of Ba. Also to the east, along transect I, we have measured Ba increases in some of the postdrilling samples, although these are of smaller magnitude than those at stations 10 and 12. There is no evidence of an increase in Ba at stations 13 or 13A from the analysis of surface samples or from sediment cores, although a small signal is more difficult to identify here because of a higher predrilling Ba concentration.

A rough calculation made in an earlier report (Bothner and others, 1983) suggested that 69 percent of the barite discharged by all eight exploratory wells could be accounted for in the sediments within the western half of a circle 130 km in diameter and centered on station 5. Inclusion of areas to the east of station 5, particularly in light of the small increases in Ba measured during the third year at stations 2 and 3, would increase the percentage of drilling-related Ba accounted for in the sediments.

We conclude that the barite from drilling mud is associated with the fine sediment fraction in low concentration and is widely distributed.

The overall results of this study have important implications in predicting the fate and effects of any contaminants discharged on Georges Bank which have an affinity for sediments or suspended particulates. For those contaminants that are rendered harmless by dilution, the tidal and storm currents are sufficient to disperse material over wide areas. Benthic organisms can assist in dispersing a contaminant added to the sea floor to deeper horizons in the sediments. These processes act quickly; half of the barite inventory at the station 5 drill site was removed from the 0-2-cm sediment layer in 0.34 years. For those contaminants known or presently unknown to be dangerous at any concentration, or for those contaminants that are added in excess of the system's capacity to dilute, the same energetic processes of dispersion will endanger a wide area of the bank.

SUMMARY OF IMPORTANT FINDINGS

1. Barium (present in barite, a major constituent of drilling mud) has increased by a factor of 5.9 in bulk (unfractionated) sediments 200 m from the drill site in block 410 as a result of drilling. The maximum barium concentration (172 ppm) was within the range of predrilling concentrations (28 ppm-300 ppm) measured at other sampling stations of this program. Because of the low toxicity of barium in the form of barite ($BaSO_4$), no adverse chemical stress to bottom-dwelling organisms is expected from these measured increases in barium concentrations. This prediction is being tested by the biological studies conducted within the Monitoring Program (Battelle-WHOI, 1984). No drilling-related changes in the concentrations of chromium or of other metals have been observed in bulk sediments from any of the locations sampled in this program.
2. Of the barite discharged to the ocean waters while drilling in Block 312, we estimate that 25 percent was present in the sediments within 6 km of the well at the time of the fifth monitoring cruise which was conducted 4 weeks after drilling was completed.
3. The inventory of barite, which accumulated as a result of drilling in Block 312, has decreased steadily for almost a year during the period following drilling with a "half-life" of 0.34 years. A much slower rate ("half-life" 3.4 years) is estimated for the period between cruises 8 and 12. At the time of cruise 12, the Ba inventory between 0.5-2 km from the well site was approximately 12 percent higher than the predrilling value.
4. The barite from drilling mud is associated with the fine sediment fraction in low concentration and is widely distributed. Its fate is closely linked to the energetic sediment transport processes characteristic of this region. We found evidence for Ba transport and

deposition to the west of the drilling activity: at stations 10 and 12 along transect III, at new coring stations 50 km west of transect III, in sediment-trap material and sediments from the head of Lydonia Canyon, and from sediments near the head of Oceanographer Canyon. In addition, we found peaks in the concentration of Ba with time at upstream control stations 2 and 3, located 35 km northeast of the nearest drilling activity. The data from sediment-trap analyses suggest that barite which is originally deposited near a drill site in this area can be resuspended to at least 25 m above the sea floor.

RECOMMENDATIONS FOR FUTURE WORK

In this three year study we have shown that Ba introduced to Georges Bank during the exploratory phase of drilling is distributed over wide areas of the bank. The rates at which the concentrations of Ba decrease in the surface sediments near a well have been estimated. The processes responsible for the decrease in concentration and the redistribution of Ba are: a.) resuspension and transport in response to strong currents; b.) physical and biological mixing of the surficial sediments; and c.) possible dilution by the local accumulation of less contaminated sediments. Because these findings have application in predicting the fate of future pollutants on Georges Bank, we recommend that the following specific studies be continued beyond the third year of this monitoring program:

1. Three replicate grab samples should be collected for chemical analysis at each of the 29 site-specific stations during the fourth and fifth years after the initiation of this program. These data are needed to more accurately determine the slower rate of Ba removal from surface sediments over a longer time interval.

2. Undisturbed sediment cores 30-40 cm long should be collected near the drill sites at stations 5 and 16 at least once per year for at least two years. Ba depth profiles of the fine and bulk sediment will determine the rates of sediment mixing processes and will determine the relative importance of erosion and mixing in explaining the decrease in the Ba concentration in surface sediment.
3. Stations that will be sampled for benthic infaunal studies beyond the third year of this program should also be sampled for metals. Particular emphasis should be given to stations to the west of the drilling area (stations 7A, 8, 9, 12, 13, 13A, and control station 2) to evaluate any long-term accumulation of Ba in expected areas of deposition.
4. Further analysis and publication of these results should be accomplished in order to maximize the scientific value of this program.

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Appendix table 1A. - Navigation data for station blends and individual samples analyzed for chemistry.

[Time delay 1 (Caribou, Maine) and time delay 4 (Carolina Beach, N.C.) are Loran-C time delay values for the 9960 Loran-C chain]

Field no.	Collection date (YrMoDy)	Water depth (m)	Latitude (degrees)	Longitude (degrees)	Time Delay 1 (µseconds)	Time Delay 4 (µseconds)
M09-01-00-BL	830714	64	41.21533	-67.25046	13172.3	43615.3
M09-02-00-BL	830714	75	40.99789	-66.94499	13156.7	43531.7
M09-02-00-G	830714	75	40.99818	-66.94467	13156.6	43531.8
M09-02-00-H	830714	75	40.99884	-66.94699	13156.9	43531.7
M09-02-00-I	830714	75	40.99667	-66.94333	13156.6	43531.7
M09-03-00-BL	830715	100	40.90929	-66.79323	13144.3	43496.6
M09-04-00-BL	830718	67	40.85106	-68.00763	13464.4	43529.4
M09-04-00-G	830718	67	40.85051	-68.00667	13464.3	43529.3
M09-04-00-H	830718	67	40.84967	-68.00818	13464.9	43529.5
M09-04-00-I	830718	67	40.85300	-68.00800	13464.1	43529.4
M09-05-01-BL	830716	84	40.72804	-67.83029	13448.0	43455.0
M09-05-01-G	830716	84	40.74451	-67.84518	13447.8	43455.0
M09-05-01-H	830716	84	40.73717	-67.83932	13448.1	43455.0
M09-05-01-I	830716	84	40.72166	-67.82516	13448.3	43454.9
M09-05-02-BL	830716	82	40.73228	-67.82709	13446.0	43455.2
M09-05-03-BL	830716	82	40.71400	-67.81010	13446.1	43456.8
M09-05-04-BL	830716	82	40.74571	-67.85201	13449.3	43455.2
M09-05-05-BL	830716	82	40.74383	-67.84480	13447.9	43453.2
M09-05-06-BL	830716	82	40.73434	-67.82411	13444.8	43454.3
M09-05-07-BL	830718	77	40.72689	-67.81306	13443.8	43457.2
M09-05-08-BL	830716	80	40.71577	-67.80827	13445.2	43458.3
M09-05-09-BL	830716	84	40.73351	-67.83792	13448.6	43457.7
M09-05-10-BL	830716	86	40.75400	-67.86751	13451.4	43455.4
M09-05-11-BL	830716	86	40.75529	-67.86902	13451.4	43453.4
M09-05-12-BL	830716	86	40.74272	-67.85017	13449.6	43452.0
M09-05-13-BL	830718	80	40.74389	-67.84309	13447.4	43452.6
M09-05-14-BL	830716	86	40.73911	-67.81653	13441.6	43454.0
M09-05-15-BL	830718	77	40.72833	-67.80101	13440.2	43458.7
M09-05-16-BL	830717	78	40.71061	-67.79599	13443.3	43460.9
M09-05-17-BL	830718	77	40.73189	-67.83528	13448.3	43459.8
M09-05-18-BL	830717	84	40.75423	-67.87709	13453.8	43456.3
M09-05-19-BL	830718	78	40.75751	-67.88510	13455.2	43451.4
M09-05-20-BL	830717	84	40.74617	-67.86246	13452.0	43448.6
M09-05-21-BL	830718	78	40.73900	-67.83401	13446.2	43450.5
M09-05-22-BL	830717	84	40.72361	-67.77943	13435.7	43453.6
M09-05-23-BL	830718	79	40.72211	-67.78902	13438.6	43467.4
M09-05-24-BL	830718	77	40.72800	-67.83749	13449.9	43465.1
M09-05-25-BL	830717	89	40.75945	-67.90427	13459.8	43456.9
M09-05-26-BL	830717	82	40.78095	-67.93378	13462.3	43447.9
M09-05-27-BL	830718	80	40.77517	-67.90544	13456.2	43442.8
M09-05-28-BL	830717	84	40.72701	-67.75940	13429.6	43452.3
M09-05-29-BL	830717	86	40.77389	-67.94267	13466.4	43458.9
M09-06-00-BL	830716	102	40.83046	-67.99422	13466.0	43425.6

Appendix table 1A. - Navigation data for station blends and individual samples analyzed for chemistry-Continued

[Time delay 1 (Caribou, Maine) and time delay 4 (Carolina Beach, N.C.) are Loran-C time delay values for the 9960 Loran-C chain]

Field no.	Collection date (YrMoDy)	Water depth (m)	Latitude (degrees)	Longitude (degrees)	Time Delay 1 (µseconds)	Time Delay 4 (µseconds)
M09-07-A0-BL	830716	167	40.87450	-68.05090	13470.2	43411.3
M09-08-00-BL	830715	152	40.91461	-68.05011	13459.8	43379.0
M09-09-00-BL	830719	144	40.44423	-68.16521	13604.0	43394.0
M09-10-00-BL	830719	66	40.84872	-68.71378	13661.8	43502.9
M09-11-00-BL	830719	86	40.51328	-68.56345	13698.0	43433.6
M09-12-00-BL	830719	108	40.36900	-68.49722	13712.1	43378.0
M09-13-00-BL	830720	70	40.48739	-70.20982	14201.9	43496.1
M09-13-A0-BL	830720	80	40.49939	-71.01083	14464.8	43543.8
M09-13-A0-G	830720	80	40.49900	-71.01167	14465.2	43543.7
M09-13-A0-H	830720	80	40.50000	-71.01067	14464.7	43544.1
M09-13-A0-I	830720	80	40.49917	-71.01018	14464.6	43543.6
M09-14-A0-BL	830714	164	41.96239	-68.52245	13299.1	43931.3
M09-16-00-BL	830715	142	40.62461	-67.25999	13328.4	43407.0
M09-16-00-G	830715	142	40.62584	-67.26102	13328.4	43407.2
M09-16-00-H	830715	142	40.62550	-67.26083	13328.3	43407.1
M09-16-00-I	830715	142	40.62251	-67.25818	13328.4	43406.8
M09-17-00-BL	830715	141	40.63172	-67.23453	13320.4	43409.5
M09-18-00-BL	830715	152	40.62083	-67.28694	13335.9	43402.9
M10-01-00-BL	831114	55	41.20695	-67.24182	13172.4	43615.1
M10-02-00-BL	831114	68	40.98740	-66.93214	13156.4	43532.0
M10-02-00-G	831114	68	40.98700	-66.93318	13156.8	43531.9
M10-02-00-H	831114	68	40.98783	-66.93185	13156.2	43532.1
M10-02-00-I	831114	68	40.98751	-66.93150	13156.3	43532.0
M10-03-00-BL	831114	92	40.89439	-66.77711	13144.4	43496.7
M10-04-00-BL	831113	62	40.84618	-68.00310	13464.4	43529.1
M10-04-00-G	831113	62	40.84600	-68.00317	13464.4	43529.0
M10-04-00-H	831113	62	40.84666	-68.00302	13464.3	43529.3
M10-04-00-I	831113	62	40.84584	-68.00317	13464.5	43529.1
M10-05-01-BL	831115	77	40.65897	-67.76501	13447.8	43455.1
M10-05-01-G	831115	77	40.65900	-67.76482	13447.7	43455.1
M10-05-01-H	831115	77	40.65894	-67.76482	13447.7	43455.0
M10-05-01-I	831115	77	40.65900	-67.76534	13448.0	43455.1
M10-05-02-BL	831115	77	40.66026	-67.75900	13446.0	43455.3
M10-05-03-BL	831115	76	40.66472	-67.76411	13446.3	43457.1
M10-05-04-BL	831115	77	40.65961	-67.77042	13449.1	43455.5
M10-05-05-BL	831115	76	40.65472	-67.76418	13448.7	43453.5
M10-05-06-BL	831115	76	40.65845	-67.75211	13444.6	43454.4
M10-05-08-BL	831115	74	40.66805	-67.76395	13445.4	43458.2
M10-05-09-BL	831116	77	40.66600	-67.77400	13448.5	43457.9
M10-05-10-BL	831116	78	40.65872	-67.77794	13451.3	43455.5
M10-05-11-BL	831116	77	40.65284	-67.77205	13451.2	43453.3
M10-05-12-BL	831117	75	40.65017	-67.76321	13449.5	43452.0
M10-05-14-BL	831117	75	40.65872	-67.74133	13441.8	43454.1

Appendix table 1A. - Navigation data for station blends and individual samples analyzed for chemistry-Continued

[Time delay 1 (Caribou, Maine) and time delay 4 (Carolina Beach, N.C.) are Loran-C time delay values for the 9960 Loran-C chain]

Field no.	Collection date (YrMoDy)	Water depth (m)	Latitude (degrees)	Longitude (degrees)	Time Delay 1 (μseconds)	Time Delay 4 (μseconds)
M11-05-06-BL	840204	78	40.65929	-67.75272	13444.6	43454.7
M11-05-08-BL	840204	77	40.66839	-67.76428	13445.3	43458.3
M11-05-09-BL	840204	78	40.66539	-67.77371	13448.6	43457.6
M11-05-10-BL	840204	81	40.65856	-67.77853	13451.5	43455.4
M11-05-11-BL	840204	81	40.65323	-67.77394	13451.6	43453.4
M11-05-12-BL	840205	80	40.65072	-67.76404	13449.6	43452.2
M11-05-14-BL	840205	79	40.65856	-67.74005	13441.5	43454.1
M11-05-16-BL	840205	79	40.67677	-67.76479	13443.4	43461.2
M11-05-18-BL	840205	82	40.65951	-67.78828	13453.8	43456.1
M11-05-20-BL	840205	80	40.64000	-67.76222	13451.8	43448.5
M11-05-22-BL	840205	80	40.65923	-67.72005	13436.1	43453.5
M11-05-25-BL	840205	83	40.65961	-67.81052	13459.6	43457.0
M11-05-28-BL	840205	77	40.65878	-67.69495	13429.7	43452.4
M11-05-29-BL	840205	84	40.66234	-67.83861	13466.3	43459.0
M11-06-00-BL	840204	98	40.57411	-67.75502	13465.8	43425.5
M11-07-A0-BL	840204	175	40.53529	-67.73618	13470.3	43411.4
M11-08-00-BL	840203	147	40.45338	-67.61902	13459.7	43379.4
M11-09-00-BL	840206	141	40.44528	-68.16283	13604.2	43394.3
M11-10-00-BL	840202	59	40.69900	-68.58539	13661.9	43502.7
M11-11-00-BL	840202	83	40.51283	-68.55896	13697.9	43433.4
M11-12-00-BL	840202	105	40.36934	-68.49362	13712.1	43378.0
M11-13-00-BL	840202	67	40.48705	-70.20667	14201.8	43496.0
M11-13-A0-BL	840201	80	40.49923	-71.01045	14465.0	43543.8
M11-13-A0-G	840201	80	40.49934	-71.01035	14465.0	43543.9
M11-13-A0-H	840201	80	40.49917	-71.01050	14465.1	43543.7
M11-13-A0-I	840201	80	40.49917	-71.01050	14465.0	43543.8
M11-16-00-BL	840203	141	40.57306	-67.20793	13328.3	43406.8
M11-16-00-G	840203	141	40.57300	-67.20799	13328.3	43406.8
M11-16-00-H	840203	141	40.57317	-67.20784	13328.3	43406.9
M11-16-00-I	840203	141	40.57300	-67.20799	13328.3	43406.8
M12-01-00-BL	840604	59	41.20828	-67.24791	13172.6	43615.1
M12-02-00-BL	840604	73	40.98830	-66.93779	13156.5	43531.9
M12-02-00-G	840604	73	40.98800	-66.93800	13156.5	43531.9
M12-02-00-H	840604	73	40.98768	-66.93649	13156.3	43531.6
M12-02-00-I	840604	73	40.98800	-66.93684	13156.3	43531.8
M12-03-00-BL	840604	98	40.89571	-66.78244	13144.2	43496.7
M12-04-00-BL	840604	66	40.84577	-68.00250	13464.4	43529.0
M12-04-00-G	840604	66	40.84651	-68.00267	13464.3	43529.3
M12-04-00-H	840604	66	40.84584	-68.00267	13464.4	43529.1
M12-04-00-I	840604	66	40.84500	-68.00217	13464.6	43528.7
M12-05-01-BL	840605	81	40.65858	-67.76938	13447.8	43455.0
M12-05-01-G	840605	81	40.65817	-67.76849	13447.7	43454.8
M12-05-01-H	840605	81	40.65968	-67.76982	13447.7	43455.3

Appendix table 1A. - Navigation data for station blends and individual samples analyzed for chemistry-Continued

[Time delay 1 (Caribou, Maine) and time delay 4 (Carolina Beach, N.C.) are Loran-C time delay values for the 9960 Loran-C chain]

Field no.	Collection date (YrMoDy)	Water depth (m)	Latitude (degrees)	Longitude (degrees)	Time Delay 1 (μseconds)	Time Delay 4 (μseconds)
M10-05-16-BL	831116	80	40.67621	-67.76422	13443.4	43460.9
M10-05-18-BL	831116	77	40.66000	-67.78818	13453.6	43456.3
M10-05-20-BL	831117	75	40.63923	-67.76273	13452.1	43448.2
M10-05-22-BL	831117	76	40.65956	-67.72011	13436.0	43453.7
M10-05-25-BL	831116	76	40.65956	-67.81050	13459.6	43457.0
M10-05-28-BL	831117	72	40.65884	-67.69400	13429.4	43452.4
M10-05-29-BL	831116	77	40.66183	-67.83951	13466.6	43458.9
M10-06-00-BL	831115	93	40.57396	-67.75591	13466.2	43425.5
M10-08-00-BL	831115	138	40.45284	-67.61853	13459.7	43379.2
M10-7A-00-BL	831115	165	40.53556	-67.73645	13470.3	43411.5
M10-09-00-BL	831118	137	40.44489	-68.16190	13604.1	43394.2
M10-10-00-BL	831113	60	40.69839	-68.58493	13661.9	43502.4
M10-11-00-BL	831113	80	40.51339	-68.56021	13698.1	43433.6
M10-12-00-BL	831113	100	40.36948	-68.49275	13711.8	37787.4
M10-13-00-BL	831113	65	40.48763	-70.20772	14202.0	43496.3
M10-13-A0-BL	831112	75	40.49961	-71.01083	14465.1	43544.0
M10-13-A0-G	831112	75	40.50017	-71.01083	14465.0	43544.2
M10-13-A0-H	831112	75	40.49950	-71.01102	14465.1	43543.9
M10-13-A0-I	831112	75	40.49917	-71.01067	14465.2	43543.8
M10-16-00-BL	831114	132	40.57323	-67.20810	13328.2	43406.9
M10-16-00-G	831114	132	40.57350	-67.20682	13327.9	43407.0
M10-16-00-H	831114	132	40.57333	-67.20818	13328.3	43406.9
M10-16-00-I	831114	132	40.57284	-67.20799	13328.4	43406.8
M10-17-00-BL	831114	134	40.58278	-67.18649	13320.7	43409.4
M10-18-00-BL	831115	137	40.55867	-67.22427	13335.8	43402.6
M11-01-00-BL	840203	58	41.20734	-67.24091	13172.0	43615.1
M11-02-00-BL	840203	72	40.98768	-66.93260	13156.4	43532.1
M11-02-00-G	840203	72	40.98768	-66.93268	13156.4	43532.1
M11-02-00-H	840203	72	40.98768	-66.93250	13156.4	43532.1
M11-02-00-I	840203	72	40.98768	-66.93268	13156.5	43532.1
M11-03-00-BL	840203	97	40.89523	-66.77608	13143.9	43496.9
M11-04-00-BL	840202	65	40.84634	-68.00317	13464.4	43529.2
M11-04-00-G	840202	65	40.84634	-68.00302	13464.3	43529.2
M11-04-00-H	840202	65	40.84634	-68.00317	13464.4	43529.2
M11-04-00-I	840202	65	40.84634	-68.00333	13464.5	43529.1
M11-05-01-BL	841115	77	40.65868	-67.76517	13447.8	43455.0
M11-05-01-G	841115	77	40.65868	-67.76517	13447.8	43455.0
M11-05-01-H	841115	77	40.65868	-67.76517	13447.8	43455.0
M11-05-01-I	841115	77	40.65868	-67.76517	13447.8	43455.0
M11-05-02-BL	840204	80	40.66084	-67.75932	13445.9	43455.5
M11-05-03-BL	840204	79	40.66478	-67.76428	13446.2	43457.0
M11-05-04-BL	840204	80	40.65939	-67.76999	13449.0	43455.5
M11-05-05-BL	840204	80	40.65483	-67.76472	13448.8	43453.6

Appendix table 1A. - Navigation data for station blends and individual samples analyzed for chemistry-Continued

[Time delay 1 (Caribou, Maine) and time delay 4 (Carolina Beach, N.C.) are Loran-C time delay values for the 9960 Loran-C chain]

Field no.	Collection date (YrMoDy)	Water depth (m)	Latitude (degrees)	Longitude (degrees)	Time Delay 1 (µseconds)	Time Delay 4 (µseconds)
M12-05-01-I	840605	81	40.65868	-67.77034	13448.1	43455.2
M12-05-02-BL	840606	81	40.66004	-67.76350	13446.0	43455.3
M12-05-03-BL	840606	81	40.66428	-67.76877	13446.3	43457.0
M12-05-04-BL	840606	81	40.65961	-67.77502	13449.1	43455.6
M12-05-05-BL	840606	81	40.65450	-67.76779	13448.5	43453.6
M12-05-06-BL	840606	81	40.65856	-67.75900	13445.2	43454.6
M12-05-07-BL	840608	79	40.66577	-67.76041	13443.8	43457.2
M12-05-08-BL	840606	79	40.66828	-67.76840	13445.2	43458.3
M12-05-09-BL	840606	81	40.66511	-67.77927	13448.9	43457.7
M12-05-10-BL	840606	81	40.65834	-67.78302	13451.4	43455.5
M12-05-11-BL	840606	83	40.65352	-67.77713	13451.1	43453.6
M12-05-12-BL	840606	81	40.64995	-67.76849	13449.8	43452.0
M12-05-13-BL	840608	81	40.65339	-67.76155	13447.1	43452.9
M12-05-14-BL	840606	81	40.65845	-67.74550	13441.6	43454.1
M12-05-15-BL	840607	77	40.67146	-67.75267	13440.4	43458.9
M12-05-16-BL	840606	79	40.67661	-67.76779	13443.1	43461.1
M12-05-17-BL	840607	80	40.67239	-67.78383	13448.3	43460.3
M12-05-18-BL	840606	82	40.65951	-67.79349	13453.9	43456.2
M12-05-18-G	840606	82	40.66051	-67.79333	13453.6	43456.5
M12-05-18-H	840606	82	40.65968	-67.79333	13453.8	43456.3
M12-05-18-I	840607	82	40.65834	-67.79382	13454.4	43455.9
M12-05-19-BL	840607	82	40.64606	-67.78555	13455.2	43451.4
M12-05-20-BL	840607	81	40.63951	-67.76804	13452.2	43448.4
M12-05-21-BL	840607	79	40.64610	-67.75223	13446.5	43450.1
M12-05-22-BL	840607	81	40.65923	-67.72307	13435.7	43453.5
M12-05-23-BL	840607	79	40.69495	-67.76849	13438.7	43467.5
M12-05-24-BL	840607	81	40.68446	-67.80042	13449.6	43465.1
M12-05-25-BL	840607	82	40.65956	-67.81534	13459.6	43457.1
M12-05-26-BL	840607	82	40.63372	-67.80154	13462.3	43447.7
M12-05-27-BL	840607	82	40.62284	-67.76883	13456.4	43442.7
M12-05-28-BL	840607	77	40.65756	-67.69939	13430.0	43452.1
M12-05-28-G	840607	77	40.65700	-67.70084	13430.5	43451.9
M12-05-28-H	840607	77	40.65784	-67.69867	13429.7	43452.2
M12-05-28-I	840607	77	40.65784	-67.69867	13429.7	43452.2
M12-05-29-BL	840607	85	40.66209	-67.84453	13466.7	43459.1
M12-05-29-G	840607	85	40.66251	-67.84518	13466.8	43459.2
M12-05-29-H	840607	85	40.66200	-67.84534	13466.9	43459.1
M12-05-29-I	840607	85	40.66251	-67.84435	13466.5	43459.1
M12-06-00-BL	840605	99	40.57378	-67.75871	13465.8	43425.5
M12-07-A0-BL	840605	166	40.53521	-67.74063	13470.2	43411.5
M12-08-00-BL	840605	150	40.45306	-67.62434	13459.9	43379.3
M12-09-00-BL	840608	142	40.44437	-68.16635	13604.3	43394.1
M12-10-00-BL	840603	63	40.69951	-68.58672	13662.1	43502.9

Appendix table 1A. - Navigation data for station blends and individual samples analyzed for chemistry-Continued

[Time delay 1 (Caribou, Maine) and time delay 4 (Carolina Beach, N.C.) are Loran-C time delay values for the 9960 Loran-C chain]

Field no.	Collection date (YrMoDy)	Water depth (m)	Latitude (degrees)	Longitude (degrees)	Time Delay 1 (μseconds)	Time Delay 4 (μseconds)
M12-11-00-BL	840603	85	40.51234	-68.55910	13698.1	43433.3
M12-12-00-BL	840603	106	40.36867	-68.49350	13712.2	43377.8
M12-13-00-BL	840603	68	40.48734	-70.20862	14202.4	43496.1
M12-13-A0-BL	840602	81	40.49996	-71.01163	14465.3	43544.1
M12-13-A0-G	840602	81	40.50034	-71.01302	14465.7	43544.4
M12-13-A0-H	840602	81	40.49884	-71.00949	14464.7	43543.5
M12-13-A0-I	840602	81	40.49934	-71.01083	14465.1	43543.8
M12-16-00-BL	840605	137	40.57289	-67.21310	13328.4	43406.9
M12-16-00-G	840605	135	40.57433	-67.21384	13328.2	43407.3
M12-16-00-H	840605	136	40.57350	-67.21350	13328.3	43407.1
M12-16-00-I	840605	137	40.57300	-67.21283	13328.3	43406.9
M12-17-00-BL	840605	140	40.58205	-67.18918	13320.3	43409.1
M12-17-00-G	840605	140	40.58067	-67.18800	13320.3	43408.6
M12-17-00-H	840605	140	40.58200	-67.18950	13320.4	43409.1
M12-17-00-I	840605	140	40.58351	-67.19000	13320.1	43409.6
M12-18-00-BL	840605	144	40.55839	-67.22861	13335.7	43402.5
M12-18-00-G	840605	144	40.55851	-67.22849	13335.6	43402.5
M12-18-00-H	840605	144	40.55867	-67.22768	13335.5	43402.6
M12-18-00-I	840605	144	40.55800	-67.22966	13336.1	43402.4

Appendix table 1B. - Navigation data for size fractionization samples and for core and grab samples subsectioned into sequential depth intervals.

Field no.	Collection date (YrMoDy)	Water depth (meters)	Latitude (degrees)	Longitude (degrees)	Time delay 1 (μseconds)	Time delay 4 (μseconds)
M10-02-00-J	831114	68	40.98734	-66.93234	13156.4	43532.0
83G9-B	840729	1,250	39.80000	-70.91667		
M04-02-00, S0-S9	820512	66	40.98828	-66.93401	13156.6	43532.3
M04-05-02, S0-S9	820513	103	40.65916	-67.76035	13446.6	43455.0
M04-16-00, S1-S9	820512	140	40.57233	-67.20840	13328.6	43406.6
M10-02-00, S0-S9	831114	68	40.98740	-66.93214	13156.4	43532.0
M10-16-00, S0-S9	831114	132	40.57323	-67.20810	13328.2	43406.9
M10-12-00-GX	831113	100	40.36948	-68.49242	13711.7	26606.0
M12-16-00-IX	840605	137	40.57300	-67.21283	13328.3	43406.9
M12-19-00-HX	840608	108	40.47350	-68.28702	13630.3	43408.8
M12-20-00-GX	840608	89	40.62184	-68.01167	13520.8	43451.4
M12-21-00-IX	840608	87	40.64784	-67.89667	13483.9	43456.1
OC140-39X	831022	99	40.27167	-69.11333	13910.0	43362.5
OC140-41X	831022	85	40.38467	-69.14999	13896.6	43407.9
OC140-8B	831024	79	40.50300	-71.01334	14465.2	43545.6

Appendix table 1C. - Sediment-trap locations and deployment dates.

Trap no.	Water depth (m)	Meters above bottom	Latitude (degrees)	Longitude (degrees)	Deployed (YrMoDy)	Recovered (YrMoDy)	General location
ST001	64	3	41.038333	-67.55817	791215	800525	Georges Bank Shelf-Georges Bank Tripod 183: Predrilling
ST103	290	20	40.52583	-67.71367	801128	810428	Lydonia Canyon axis-Station LCB: Predrilling
ST222	288	50	40.526001	-67.71400	810429	810926	Lydonia Canyon axis: Drilling starts 810724
ST301	290	20	40.526001	-67.71300	810927	820128	Lydonia Canyon axis-Station LCB: Drilling in progress
ST301	290	20	40.526001	-67.71300	810927	820128	Lydonia Canyon axis-Station LCB: Drilling in progress
ST403	300	20	40.525333	-67.71383	820131	820707	Lydonia Canyon axis-Station LCB: Drilling in progress
ST424	81	5	40.652702	-67.77071	820201	820611	1 km west of rig: Drilling in progress
ST426	300	5	40.662704	-67.69229	820201	820611	6 km east of rig: Drilling in progress
ST501	79	25	40.656502	-67.77451	820710	821111	Rig site-Block 312: Post drilling
ST502	79	20	40.656500	67.76783	820710	821111	Rig site-Block 312: Post drilling
ST505	79	3	40.656502	-67.76779	820710	821111	Rig site-Block 312: Post drilling
ST506	79	25	40.657997	-67.77499	820710	821111	1 km west of rig: Post drilling
ST508	79	10	40.657997	-67.77499	820710	821111	1 km west of rig: Post drilling
ST510	79	3	40.657997	-67.77499	820710	821111	1 km west of rig: Post drilling
ST513	77	10	40.662292	-67.69099	820711	821111	6 km east of rig: Post drilling
ST515	77	3	40.662292	-67.69099	820111	821111	6 km east of rig: Post drilling
ST536	295	20	40.52480	-67.71321	820708	821111	Lydonia Canyon axis-Station LCB: Drilling in progress
ST537	295	10	40.52483	-67.71317	820708	821111	Lydonia Canyon axis-Station LCB: Drilling in progress

Appendix table 2. - Chemical analyses of blind replicates. (Values are accurate to two significant figures.)

Field no.	Lab no.	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Hg (ppm)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)	Blind no.
M11-01-00-BL	W-225548	0.810	130	<0.020	6	<1.0	0.38	0.00	72.0	<2	4	6	4.2	
M11-01-00-BL	W-225598	.820	130	<.020	6	1.7	.39	0.00	68.0	<2	3	4	5.0	Blind #49
M11-03-00-AX6	W-226062	4.807	252	.229	92	30.	3.43	0.00	331.9	45	45	160	92.7	
M11-03-00-AX6	W-226067	4.630	227	.226	86	21.	3.39	0.00	327.5	50	35	158	96.0	Blind #56
M11-04-00-BL	W-225554	1.200	180	<.020	10	<1.0	.51	0.00	87.0	<2	6	8	6.1	
M11-04-00-BL	W-225599	1.100	180	<.020	9	1.2	.52	0.00	86.0	<2	5	8	6.6	Blind #50
M11-05-01-IX	W-225862	4.080	5712	.299	49	24.	2.99	0.00	2584.	35	38	84	81.6	
M11-05-01-IX	W-225891	3.563	5700	.168	53	23.	2.80	0.00	2316.	31	43	64	84.0	Blind #53
M11-05-06-BL	W-225584	—	35	--	--	--	--	0.00	--	--	--	--	--	
M11-05-06-BL	W-225600	.220	34	.020	4	<1.0	.41	0.00	330.0	<2	4	13	4.2	Blind #51
M11-13-00-BLX	W-225868	5.551	316	.109	69	13.	2.83	0.00	446.3	33	27	120	71.8	
M11-13-00-BLX	W-225890	4.952	291	.076	67	13.	2.69	0.00	430.6	33	31	99	71.0	Blind #52
M12-16-00-BL	W-226820	.380	73	.020	3	<1.0	.21	0.00	160.0	<2	3	<2	5.8	
M12-16-00-BL	W-226832	.360	73	.020	<2	<1.0	.20	0.00	160.0	<2	4	<2	5.8	Blind #57
M12-16-00-BL	W-226833	.360	73	.020	<2	<1.0	.20	0.00	170.0	<2	3	<2	5.8	Blind #58
OC140-41X8-10	W-226056	4.863	238	.283	83	25.	3.39	0.00	328.0	45	44	147	96.1	
OC140-41X8-10	W-226065	4.709	247	.200	86	21.	3.30	0.00	341.4	42	46	165	95.3	Blind #54
OC140-41X1214	W-226058	5.081	236	.236	95	26.	3.66	0.00	366.3	47	35	165	102.	
OC140-41X1214	W-226066	4.415	226	.269	81	20.	3.23	0.00	312.3	42	38	151	92.6	Blind #55

Appendix table 3A. Textural analysis of station blends and individual samples.

[Values accurate to two significant figures]

Field no.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Mean (ϕ)	Median (ϕ)	St.dev. (ϕ)	Very coarse sand (%)	Coarse sand (%)	Medium sand (%)	Fine sand (%)	Very fine sand (%)
M09-01-00-BL	0.00	99.67	0.21	0.13	2.24	2.28	0.56	0.00	0.00	32.49	62.69	4.59
M09-02-00-BL	5.20	94.69	.06	.05	1.07	1.11	.95	2.65	37.21	43.08	9.57	2.18
M09-02-00-G	3.61	96.19	.14	.06	1.08	1.12	.94	5.00	36.17	43.38	9.43	2.21
M09-02-00-H	6.89	92.96	.11	.05	1.08	1.21	.98	2.13	30.96	47.78	11.06	1.03
M09-02-00-I	3.80	96.12	.05	.03	1.19	1.30	.88	3.84	26.15	53.35	11.63	1.15
M09-03-00-BL	8.70	89.41	1.31	.58	1.92	2.14	1.36	.00	.98	32.99	52.31	3.13
M09-04-00-BL	.00	99.71	.17	.12	2.60	2.56	.41	.00	.00	4.29	82.16	13.26
M09-04-00-G	.38	99.36	.18	.07	2.56	2.54	.49	.00	.00	6.86	79.39	13.11
M09-04-00-H	.00	99.66	.22	.12	2.57	2.54	.50	.00	.00	9.57	75.04	15.05
M09-04-00-I	.00	99.78	.14	.07	2.66	2.59	.32	.00	.00	.00	84.52	15.26
M09-05-00-BL	2.27	97.20	.37	.16	.95	.81	.97	6.32	50.93	29.94	7.87	2.14
M09-05-00-G	3.98	95.12	.72	.18	.89	.77	1.08	7.90	49.74	29.11	4.95	3.42
M09-05-00-H	1.87	97.40	.57	.16	1.07	.93	.99	4.97	46.46	32.44	11.49	2.04
M09-05-00-I	7.27	92.42	.22	.09	.87	.81	1.08	5.64	45.93	29.39	8.78	2.68
M09-05-02-BL	1.14	98.35	.35	.16	1.21	1.12	.97	3.93	40.43	37.47	13.17	3.35
M09-05-03-BL	3.94	95.31	.59	.16	.96	.88	1.06	8.01	43.37	32.69	9.63	1.62
M09-05-04-BL	.87	98.81	.22	.10	1.19	1.14	.87	3.66	39.52	41.11	12.45	2.07
M09-05-05-BL	.63	99.07	.19	.11	1.18	1.11	.86	3.37	41.61	38.74	13.87	1.48
M09-05-06-BL	.35	99.38	.17	.10	1.17	1.11	.80	2.39	42.63	42.63	9.64	2.09
M09-05-07-BL	2.25	97.56	.12	.07	.94	.90	.88	8.29	43.90	37.07	6.74	1.56
M09-05-08-BL	5.27	93.65	.86	.23	.89	.76	1.22	11.70	43.55	26.69	7.77	3.93
M09-05-09-BL	2.68	96.38	.71	.22	.93	.79	1.09	10.51	46.46	28.43	8.96	2.03
M09-05-10-BL	.51	98.82	.48	.19	1.14	1.01	.95	4.05	45.16	37.16	9.48	2.97
M09-05-11-BL	.00	99.71	.17	.12	1.08	.96	.91	7.88	44.07	33.90	11.57	2.29
M09-05-12-BL	.20	99.53	.19	.09	1.60	1.57	.76	.49	19.61	52.25	25.18	1.99
M09-05-13-BL	.00	99.72	.19	.09	1.39	1.35	.83	1.50	32.90	45.08	17.25	2.99
M09-05-14-BL	.61	99.08	.22	.09	1.03	.92	.76	2.48	51.03	36.76	8.32	.49
M09-05-15-BL	4.03	95.62	.25	.09	1.01	.97	.96	4.02	43.31	38.35	7.46	2.48
M09-05-16-BL	.95	98.82	.16	.08	1.27	1.25	.96	6.42	33.99	35.08	21.25	2.07
M09-05-17-BL	2.74	96.47	.60	.20	.89	.74	1.08	10.51	49.78	26.14	6.56	3.48
M09-05-18-BL	.45	98.84	.52	.19	1.23	1.06	.93	.99	46.25	35.88	13.25	2.47
M09-05-19-BL	3.56	95.74	.50	.20	1.10	.94	1.04	.96	48.34	32.75	10.24	3.45
M09-05-20-BL	.91	98.66	.30	.13	1.24	1.20	.92	2.96	37.39	44.40	9.96	3.95
M09-05-21-BL	.47	99.33	.14	.05	1.04	.96	.72	2.49	49.16	40.83	5.36	1.49
M09-05-22-BL	.31	99.42	.19	.08	1.06	.95	.72	1.49	51.00	38.38	8.05	.50
M09-05-23-BL	.00	99.70	.20	.10	1.26	1.23	.73	.50	38.48	48.36	11.36	1.00
M09-05-24-BL	4.75	94.75	.37	.13	1.34	1.37	1.05	.47	27.58	46.42	16.39	3.89
M09-05-25-BL	.36	99.20	.31	.13	1.31	1.20	.88	.50	41.16	39.19	15.37	2.98
M09-05-26-BL	2.90	95.70	1.08	.33	1.28	1.15	1.18	2.48	39.24	34.83	15.22	3.92
M09-05-27-BL	.00	99.72	.18	.10	1.45	1.44	.68	.00	23.93	59.84	14.46	1.49
M09-05-28-BL	3.60	96.21	.14	.05	.85	.79	.87	7.12	49.74	31.75	7.12	.57
M09-05-29-BL	7.57	90.32	1.47	.65	2.03	2.20	1.42	.00	4.70	28.90	44.61	12.11
M09-06-00-BL	.56	96.27	2.07	1.10	2.52	2.42	1.15	.00	1.06	27.43	50.06	17.72
M09-07A-00-BL	.00	70.34	19.28	10.37	4.61	3.69	1.97	.00	.00	.00	4.99	65.35
M09-08-00-BL	.00	98.16	1.36	.49	1.80	1.66	1.06	.00	18.85	46.91	25.62	6.78
M09-09-00-BL	.24	97.47	1.73	.56	2.37	2.32	.99	.00	2.54	32.65	45.90	16.38
M09-10-00-BL	.73	99.11	.11	.05	1.77	1.75	.74	.00	11.89	49.85	34.30	3.07
M09-11-00-BL	.00	98.85	.78	.37	2.91	2.80	.63	.00	.00	.00	62.87	35.98
M09-12-00-BL	.00	94.83	4.02	1.14	1.91	1.61	1.44	.00	21.62	46.18	20.11	7.02
M09-13A-00-BL	.00	7.35	74.09	18.56	6.51	6.49	1.61	.00	.00	.00	.00	7.35
M09-13A-00-G	.00	6.92	74.45	18.63	6.65	6.67	1.53	.00	.00	.00	.00	6.92
M09-13A-00-H	.00	8.24	63.69	28.07	6.79	6.73	1.90	.00	.00	.00	.00	8.24
M09-13A-00-I	.00	6.77	75.99	17.23	6.46	6.47	1.57	.00	.00	.00	.00	6.77
M09-13-00-BL	.00	53.43	37.44	9.13	4.83	3.93	1.96	.00	.00	.32	5.82	47.29
M09-14A-00-BL	.00	12.22	63.46	24.32	6.48	6.52	1.87	.00	.00	.00	.00	12.22
M09-16-00-BL	1.74	97.60	.46	.20	1.09	.99	1.03	7.32	41.18	35.53	10.93	2.64
M09-16-00-G	.86	98.15	.65	.33	1.12	1.03	1.03	6.78	41.32	37.69	10.50	1.87
M09-16-00-H	2.09	97.03	.61	.27	1.13	1.11	1.09	9.12	34.35	39.10	12.33	2.13
M09-16-00-I	.87	98.15	.69	.29	1.06	.92	1.07	9.52	43.28	32.69	10.11	2.55
M09-17-00-BL	1.08	98.56	.25	.11	1.35	1.37	.82	1.58	27.99	52.83	14.58	1.58
M09-18-00-BL	.20	99.11	.41	.28	2.15	2.17	.66	.00	.00	40.24	56.49	2.38
M10-01-00-BL	.24	99.68	.05	.03	2.15	2.22	.53	.00	1.20	35.08	60.31	3.09
M10-02-00-BL	1.64	98.24	.08	.04	1.31	1.32	.80	.59	31.73	50.69	12.77	2.46
M10-02-00-G	1.52	98.36	.09	.03	1.46	1.49	.74	.00	22.62	53.12	22.62	.00
M10-02-00-H	1.33	98.59	.06	.02	1.22	1.24	.86	4.44	33.03	46.53	11.24	3.35
M10-02-00-I	.76	99.08	.12	.04	1.36	1.36	.72	.00	30.22	52.81	14.86	1.19
M10-03-00-BL	5.27	92.42	1.63	.67	2.10	2.25	1.28	.00	4.25	26.43	56.47	5.27
M10-04-00-BL	.00	99.83	.11	.07	2.50	2.49	.48	.00	.00	13.78	73.67	12.48
M10-04-00-G	.46	99.34	.13	.08	2.63	2.58	.46	.00	.00	2.18	80.96	16.19
M10-04-00-H	.00	99.79	.13	.08	2.71	2.62	.36	.00	.00	.00	80.03	19.76
M10-04-00-I	.00	99.81	.11	.08	2.69	2.61	.38	.00	.00	1.40	79.45	18.96

Appendix table 3A. Textural analysis of station blends and individual samples—Continued.

[Values accurate to two significant figures]

Field no.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Mean (ϕ)	Median (ϕ)	St.dev. (ϕ)	Very coarse sand (%)	Coarse sand (%)	Medium sand (%)	Fine sand (%)	Very fine sand (%)
M10-05-00-BL	3.08	96.04	0.67	0.21	1.04	1.00	1.13	10.95	35.82	36.50	9.70	3.07
M10-05-00-G	5.84	93.35	.63	.17	.91	.90	1.26	17.56	29.68	30.34	12.70	3.08
M10-05-00-H	3.91	95.17	.71	.21	.89	.80	1.12	11.71	43.02	30.73	7.33	2.48
M10-05-00-I	2.67	96.45	.70	.18	1.03	.98	1.08	11.10	36.84	33.18	15.33	.00
M10-05-02-BL	1.87	97.54	.44	.16	1.03	1.01	1.13	15.51	32.28	34.92	11.02	3.90
M10-05-03-BL	3.27	96.08	.50	.15	1.20	1.21	1.10	6.92	31.61	39.20	14.51	3.84
M10-05-04-BL	.32	99.16	.36	.16	.99	.85	1.06	15.47	40.26	28.56	11.80	3.07
M10-05-05-BL	.00	99.60	.30	.11	1.28	1.25	.97	7.77	32.17	39.94	16.13	3.59
M10-05-06-BL	.42	99.31	.19	.08	1.19	1.14	.89	5.37	38.43	41.41	10.63	3.57
M10-05-08-BL	1.55	97.68	.57	.20	1.16	1.12	1.18	13.28	30.87	35.94	11.73	5.86
M10-05-09-BL	3.72	95.69	.43	.16	.98	.98	1.22	18.08	28.90	31.86	12.63	4.21
M10-05-10-BL	.33	98.78	.68	.21	.97	.82	1.16	17.87	38.92	29.05	8.00	4.94
M10-05-11-BL	.00	99.76	.17	.07	1.53	1.50	.81	1.90	22.94	50.18	21.05	3.69
M10-05-12-BL	.95	98.89	.11	.06	1.57	1.56	.76	.59	17.40	55.78	22.74	2.38
M10-05-14-BL	.16	99.68	.11	.05	1.15	1.07	.82	4.09	42.86	39.37	10.97	2.39
M10-05-16-BL	3.17	96.54	.19	.09	1.21	1.25	1.01	5.89	30.41	41.52	16.41	2.32
M10-05-18-BL	.61	98.54	.64	.21	1.28	1.21	1.10	8.28	33.79	34.99	17.24	4.24
M10-05-18-G	.57	98.81	.46	.16	1.26	1.23	1.11	11.37	30.23	34.59	18.28	4.44
M10-05-18-H	.24	99.47	.22	.07	1.11	1.05	1.07	15.62	32.53	32.53	14.32	4.57
M10-05-18-I	.91	98.15	.77	.18	1.31	1.25	1.15	9.71	31.02	33.27	18.94	5.21
M10-05-20-BL	3.51	95.73	.57	.19	.93	.90	1.21	18.57	31.11	32.94	9.00	4.21
M10-05-22-BL	.24	99.44	.24	.08	.95	.87	.97	15.12	39.97	32.71	9.05	2.59
M10-05-25-BL	.87	97.97	.78	.37	1.55	1.49	1.13	3.24	28.21	35.86	25.57	5.10
M10-05-28-BL	5.62	94.18	.15	.05	.89	.88	1.09	11.77	37.21	32.87	8.66	3.67
M10-05-28-G	4.96	94.68	.28	.08	.84	.83	1.08	14.20	37.11	33.42	7.39	2.55
M10-05-28-H	5.08	94.76	.12	.04	.69	.68	1.05	21.04	35.35	29.47	7.10	1.80
M10-05-28-I	5.37	94.51	.08	.04	.89	.89	1.08	12.76	35.72	33.18	9.54	3.31
M10-05-29-BL	6.51	91.88	1.00	.61	2.29	2.43	1.31	.00	.00	20.95	53.02	17.91
M10-05-29-G	5.65	92.80	1.10	.45	2.30	2.44	1.27	.00	2.14	19.02	52.71	19.02
M10-05-29-H	3.40	95.42	.78	.40	2.37	2.43	1.08	.00	.00	24.15	51.90	19.37
M10-05-29-I	3.54	94.87	1.10	.50	2.40	2.47	1.15	.00	2.27	17.93	55.60	19.06
M10-06-00-BL	1.13	96.22	1.98	.67	2.40	2.36	1.11	.00	2.50	29.16	47.82	16.74
M10-07A-00-BL	.00	77.34	18.09	4.57	4.05	3.61	1.45	.00	.00	.00	7.81	69.53
M10-08-00-BL	.00	98.25	1.20	.55	1.79	1.64	1.08	.00	19.16	48.54	22.30	8.25
M10-09-00-BL	.00	97.18	1.98	.84	2.53	2.44	1.07	.00	1.75	29.06	43.82	22.55
M10-10-00-BL	1.14	98.78	.05	.03	1.66	1.65	.80	.00	17.88	47.41	30.03	3.46
M10-11-00-BL	.00	98.81	.79	.40	3.00	2.92	.64	.00	.00	.00	54.44	44.37
M10-12-00-BL	1.58	95.04	2.64	.74	1.90	1.76	1.30	.00	18.44	39.63	27.75	9.22
M10-13A-00-BL	.00	7.83	72.12	20.05	6.69	6.68	1.56	.00	.00	.00	.78	7.05
M10-13A-00-G	.00	7.65	77.18	15.17	6.24	6.10	1.60	.00	.00	.00	.77	6.88
M10-13A-00-H	.00	6.25	77.95	15.80	6.33	6.18	1.57	.00	.00	.00	.63	5.62
M10-13A-00-I	.00	7.42	76.16	16.42	6.43	6.36	1.57	.00	.00	.00	.74	6.68
M10-13-00-BL	.00	58.24	34.65	7.11	4.67	3.84	1.81	.00	.00	.00	7.16	51.08
M10-16-00-BL	1.17	98.06	.52	.25	1.10	1.08	1.03	9.71	35.89	39.03	12.16	1.27
M10-16-00-G	1.34	97.47	.82	.36	1.28	1.21	1.16	7.41	33.53	37.24	14.91	4.39
M10-16-00-H	1.68	97.54	.55	.23	1.02	1.00	1.05	11.90	36.28	38.04	9.56	1.76
M10-16-00-I	.96	98.36	.50	.18	1.03	.95	1.09	15.34	35.32	31.18	14.75	1.77
M10-17-00-BL	.67	99.04	.20	.09	1.36	1.35	.84	1.68	32.29	44.37	19.01	1.69
M10-17-00-G	.59	99.25	.12	.04	1.39	1.38	.73	.00	30.37	49.63	18.16	1.09
M10-17-00-H	1.61	98.31	.06	.03	1.21	1.25	.89	5.90	31.36	44.43	14.26	2.36
M10-17-00-I	1.05	98.19	.54	.22	1.49	1.46	.97	1.18	27.69	43.99	22.29	3.04
M10-18-00-BL	.51	98.93	.37	.19	2.21	2.27	.64	.00	.00	32.65	63.02	3.26
M10-18-00-G	.25	99.09	.48	.18	2.13	2.12	.67	.00	.00	43.70	50.93	4.46
M10-18-00-H	.34	99.33	.20	.13	2.19	2.24	.60	.00	.00	35.36	60.19	3.87
M10-18-00-I	.00	99.48	.35	.17	2.14	2.15	.61	.00	.00	42.08	53.82	3.58
M11-01-00-BL	.25	99.66	.05	.04	2.21	2.25	.56	.00	.00	34.98	58.31	6.38
M11-02-00-BL	.20	99.64	.11	.05	1.41	1.38	.76	.00	31.19	49.12	16.34	2.99
M11-02-00-G	.87	99.01	.08	.04	1.50	1.48	.79	.59	22.67	53.57	18.31	3.87
M11-02-00-H	.44	99.44	.08	.04	1.61	1.58	.70	.00	16.80	56.59	23.66	2.49
M11-02-00-I	1.08	98.76	.11	.05	1.44	1.43	.79	.00	27.45	49.98	18.76	2.57
M11-03-00-BL	7.79	89.54	1.84	.83	2.14	2.32	1.42	.00	1.70	21.40	59.10	7.35
M11-04-00-BL	.00	99.62	.24	.14	2.69	2.61	.47	.00	.00	2.89	76.60	20.13
M11-04-00-G	.39	99.22	.21	.18	2.65	2.59	.56	.00	.00	4.66	75.71	18.85
M11-04-00-H	.74	99.00	.17	.09	2.65	2.61	.58	.00	.00	4.85	73.06	21.09
M11-04-00-I	.00	99.51	.33	.16	2.71	2.63	.46	.00	.00	1.39	77.72	20.40

Appendix table 3A. Textural analysis of station blends and individual samples—Continued.

[Values accurate to two significant figures]

Field no.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Mean (ϕ)	Median (ϕ)	St.dev. (ϕ)	Very coarse sand (%)	Coarse sand (%)	Medium sand (%)	Fine sand (%)	Very fine sand (%)
M11-05-00-BL	6.41	92.59	0.76	0.24	1.18	1.20	1.28	6.76	29.44	37.41	13.52	5.55
M11-05-00-G	4.07	94.27	1.21	.46	1.39	1.34	1.32	5.37	27.90	36.77	17.15	7.07
M11-05-00-H	9.47	89.51	.83	.19	.88	.82	1.30	8.86	38.76	27.92	10.12	3.85
M11-05-00-I	2.18	97.16	0.49	0.17	1.16	1.10	1.12	9.62	34.49	35.76	12.14	5.15
M11-05-02-BL	3.01	96.23	.52	.24	1.06	.95	1.14	8.28	40.80	33.77	8.28	5.10
M11-05-03-BL	1.59	98.14	.18	.09	1.01	.94	.93	8.15	42.88	36.61	7.55	2.95
M11-05-04-BL	1.25	97.98	.57	.20	.88	.77	1.09	16.85	41.65	30.18	5.78	3.52
M11-05-05-BL	.55	98.98	.31	.17	1.20	1.14	.91	4.46	39.39	39.39	14.05	1.69
M11-05-06-BL	.79	98.54	.45	.22	1.07	1.07	1.11	15.67	30.84	38.63	9.56	3.94
M11-05-08-BL	1.96	97.15	.69	.20	1.00	.91	1.21	18.17	32.84	29.73	12.72	3.69
M11-05-09-BL	.79	98.37	.59	.25	1.07	.96	1.15	14.56	36.11	31.48	12.19	4.04
M11-05-10-BL	2.30	96.82	.64	.23	.99	.97	1.16	15.88	32.83	35.53	9.29	3.30
M11-05-11-BL	.00	99.60	.29	.11	1.17	1.13	.97	9.76	35.16	37.85	14.04	2.79
M11-05-12-BL	2.82	96.85	.24	.09	1.51	1.52	.92	.00	20.92	50.46	22.08	3.49
M11-05-14-BL	.31	99.22	.36	.11	1.09	1.04	.95	9.53	38.49	39.59	8.44	3.17
M11-05-16-BL	3.01	96.76	.17	.07	1.31	1.34	.97	3.38	28.26	44.70	17.51	2.90
M11-05-18-BL	.44	98.75	.58	.23	1.00	.87	1.05	13.14	41.67	31.99	9.68	2.27
M11-05-18-G	.21	99.29	.33	.17	.98	.84	.96	10.72	46.77	30.48	9.04	2.28
M11-05-18-H	.44	98.92	.51	.13	1.03	.93	.97	10.78	41.65	32.94	12.95	.60
M11-05-18-I	.65	98.65	.50	.20	.98	.92	1.10	17.66	34.63	32.26	11.74	2.37
M11-05-20-BL	2.84	96.40	.58	.18	1.04	1.10	1.12	13.88	29.40	39.82	10.99	2.31
M11-05-22-BL	.00	99.65	.26	.09	.89	.82	.86	13.35	44.54	33.39	7.97	.40
M11-05-25-BL	.00	99.25	.53	.22	1.41	1.33	1.05	5.06	33.05	36.42	19.66	5.06
M11-05-28-BL	4.41	95.32	.21	.07	.64	.64	.96	19.54	40.79	29.84	4.57	.57
M11-05-28-G	3.89	95.87	.18	.06	.60	.59	.99	26.08	34.03	29.43	6.23	.10
M11-05-28-H	6.51	93.30	.14	.06	.65	.64	1.00	14.92	44.79	27.15	4.75	1.68
M11-05-28-I	1.93	97.83	.18	.06	.81	.77	.96	17.12	40.01	32.58	6.26	1.86
M11-05-29-BL	5.55	92.96	.97	.52	2.12	2.26	1.28	.00	4.46	27.61	46.76	14.13
M11-05-29-G	7.24	90.94	1.23	.59	2.16	2.33	1.38	.00	2.36	24.10	49.38	15.10
M11-05-29-H	11.52	87.02	1.00	.46	1.96	2.28	1.52	.00	3.30	21.59	48.21	13.92
M11-05-29-I	2.65	95.19	1.47	.69	2.15	2.15	1.19	.00	4.86	35.88	42.93	11.52
M11-06-00-BL	1.90	95.24	2.00	.85	2.55	2.52	1.18	.00	1.15	22.95	45.91	25.24
M11-07A-00-BL	.00	73.59	19.75	6.66	4.15	3.61	1.70	.00	.00	.66	12.29	60.71
M11-08-00-BL	.63	97.00	1.59	.78	1.95	1.82	1.21	.00	17.07	39.48	30.36	10.09
M11-09-00-BL	1.10	96.36	1.68	.86	2.52	2.47	1.09	.00	.00	26.69	47.70	22.07
M11-10-00-BL	.97	97.10	1.31	.63	1.81	1.75	1.12	1.07	14.95	44.27	33.11	3.69
M11-11-00-BL	.00	98.64	.92	.44	2.98	2.90	.68	.00	.00	1.58	53.76	43.30
M11-12-00-BL	.43	95.73	2.93	.92	1.83	1.64	1.36	1.72	23.17	38.29	23.74	8.80
M11-13A-00-BL	.00	7.39	77.49	15.12	6.26	6.14	1.59	.00	.00	.00	.00	7.39
M11-13A-00-G	.00	7.73	80.13	12.15	6.11	5.95	1.52	.00	.00	.00	.00	7.73
M11-13A-00-H	.00	6.58	79.92	13.49	6.16	5.95	1.55	.00	.00	.00	.00	6.58
M11-13A-00-I	.00	6.27	74.80	18.93	6.41	6.19	1.71	.00	.00	.00	.00	6.27
M11-13-00-BL	.00	65.95	28.08	5.97	4.37	3.70	1.76	.00	.00	.79	11.41	53.75
M11-16-00-BL	1.07	97.93	.70	.30	1.18	1.13	1.09	8.82	35.45	37.11	14.40	2.25
M11-16-00-G	.81	98.39	.57	.23	1.19	1.21	.97	7.08	32.76	44.97	12.79	.78
M11-16-00-H	.88	97.95	.87	.29	1.20	1.18	1.14	11.17	30.46	41.05	11.75	3.53
M11-16-00-I	2.22	96.98	.54	.26	.91	.85	1.17	19.30	33.45	32.88	7.95	3.40
M11-17-00-BL	.75	98.50	.51	.24	1.43	1.34	.98	.59	33.29	44.82	14.68	5.12
M11-17-00-G	.36	98.04	1.04	.56	1.34	1.24	1.06	1.18	37.84	44.12	13.73	1.17
M11-17-00-H	.44	98.37	.84	.36	1.48	1.43	.99	2.16	24.69	52.24	16.52	2.76
M11-17-00-I	2.61	94.79	1.74	.87	1.61	1.53	1.26	.00	22.08	47.68	23.89	1.13
M11-18-00-BL	.50	99.00	.31	.19	2.10	2.05	.72	.00	.00	47.22	45.05	6.73
M11-18-00-G	.00	99.46	.37	.17	2.12	2.14	.59	.00	.00	42.37	55.30	1.79
M11-18-00-H	.20	98.99	.52	.28	2.13	2.11	.71	.00	.00	44.55	49.79	4.66
M11-18-00-I	.89	98.72	.22	.17	2.07	2.08	.68	.00	.00	45.22	50.15	3.36
M12-01-00-BL	.66	99.19	.08	.07	2.14	2.20	.63	.29	.30	37.10	57.13	4.37
M12-02-00-BL	2.36	97.48	.09	.07	1.28	1.34	.75	.29	27.20	58.68	10.44	.87
M12-02-00-G	1.25	98.52	.14	.09	1.17	1.13	.76	.00	43.15	43.75	11.03	.59
M12-02-00-H	.65	99.27	.05	.03	1.21	1.19	.70	.00	40.20	48.65	8.33	2.09
M12-02-00-I	1.88	97.88	.12	.12	1.21	1.25	.76	.00	35.14	52.66	9.69	.39
M12-03-00-BL	7.45	85.10	4.74	2.71	2.23	2.17	1.84	.00	1.28	32.93	49.02	1.87
M12-04-00-BL	.30	99.04	.40	.26	2.60	2.55	.53	.30	.30	.30	88.24	9.91
M12-04-00-G	.20	99.48	.18	.14	2.61	2.56	.37	.00	.00	.60	88.54	10.34
M12-04-00-H	.21	98.99	.46	.34	2.49	2.48	.61	.00	.59	9.61	82.36	6.43
M12-04-00-I	.22	99.38	.22	.18	2.59	2.54	.37	.00	.00	.00	91.83	7.55

Appendix table 3A. Textural analysis of station blends and individual samples--Continued.

[Values accurate to two significant figures]

Field no.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Mean (ϕ)	Median (ϕ)	St.dev. (ϕ)	Very coarse sand (%)	Coarse sand (%)	Medium sand (%)	Fine sand (%)	Very fine sand (%)
M12-05-00-BL	1.62	97.42	0.55	0.41	0.091	0.72	0.95	1.26	65.18	22.99	7.89	0.10
M12-05-00-G	1.68	97.10	.84	.38	.80	.66	1.01	8.44	60.79	23.40	3.40	1.07
M12-05-00-H	1.68	97.23	.75	.34	.90	.73	.97	3.79	61.25	25.38	5.93	.88
M12-05-00-I	.95	98.10	.63	.32	1.13	1.00	.90	.00	49.05	40.61	7.65	.79
M12-05-02-BL	2.59	96.92	.33	.16	.89	.81	.94	8.04	48.56	33.34	5.23	1.75
M12-05-03-BL	1.52	96.96	1.11	.41	.71	.58	1.14	20.26	48.97	22.11	4.94	.68
M12-05-04-BL	1.61	96.78	1.13	.48	.67	.54	1.12	16.26	59.71	16.46	3.29	1.06
M12-05-05-BL	.27	99.33	.27	.12	.88	.77	.83	10.14	51.15	30.40	7.75	.00
M12-05-06-BL	.98	98.16	.59	.27	.99	.80	.89	.78	60.57	29.25	6.19	1.37
M12-05-07-BL	2.25	97.43	.21	.11	.84	.73	.72	.59	64.40	28.64	3.32	.48
M12-05-08-BL	7.11	91.28	1.20	.42	.62	.54	1.26	17.89	46.55	22.45	2.47	1.91
M12-05-09-BL	1.88	96.88	.94	.30	.78	.64	1.17	19.76	44.37	24.90	4.56	3.29
M12-05-10-BL	1.34	98.22	.29	.15	.60	.47	1.05	26.62	46.76	15.91	5.89	3.05
M12-05-11-BL	.70	98.11	.86	.33	.99	.82	1.05	8.14	50.33	30.61	6.97	2.06
M12-05-12-BL	.40	99.05	.41	.14	1.11	.92	.83	.59	53.19	32.09	12.38	.80
M12-05-13-BL	.35	99.15	.36	.14	1.04	.89	.86	3.96	51.07	34.60	7.43	2.09
M12-05-14-BL	.63	98.90	.32	.15	.83	.67	.70	.00	73.38	20.18	5.14	.30
M12-05-15-BL	4.00	95.36	.50	.13	.87	.76	.97	4.30	55.11	28.42	5.44	2.10
M12-05-16-BL	3.63	95.27	.81	.30	.61	.49	1.18	25.72	42.39	19.63	5.81	1.72
M12-05-17-BL	2.87	96.34	.57	.22	.87	.74	1.07	11.27	48.46	26.69	7.80	2.12
M12-05-18-BL	1.31	97.66	.76	.28	1.02	.76	1.05	2.73	60.65	23.04	6.55	4.68
M12-05-18-G	.56	98.17	1.00	.28	.95	.75	.99	5.98	57.93	24.44	9.52	.30
M12-05-18-H	.40	97.90	1.26	.44	1.09	.84	1.17	7.73	49.83	27.81	9.39	3.14
M12-05-18-I	.24	98.78	.77	.21	1.12	.89	.92	.30	55.32	32.20	8.00	2.96
M12-05-19-BL	2.64	96.64	.53	.18	1.08	.91	.97	.29	51.80	32.37	9.67	2.51
M12-05-20-BL	.35	99.34	.22	.09	1.18	1.11	.75	.49	44.41	43.41	9.74	1.29
M12-05-21-BL	1.28	98.50	.16	.06	.71	.62	.75	7.88	66.38	19.21	3.84	1.18
M12-05-22-BL	.00	99.64	.27	.09	.89	.74	.63	.30	67.35	27.70	3.99	.30
M12-05-23-BL	.28	99.04	.48	.20	1.05	.89	.84	1.58	54.28	34.37	7.82	.99
M12-05-24-BL	.46	99.38	.10	.07	1.52	1.51	.71	.09	20.87	56.55	20.27	1.59
M12-05-25-BL	0.44	98.44	.81	.31	1.23	1.03	.98	.39	48.14	34.95	12.89	2.07
M12-05-26-BL	4.88	93.86	.88	.37	.93	.79	1.14	4.98	50.59	28.16	9.29	.85
M12-05-27-BL	.00	99.79	.14	.07	1.35	1.36	.62	.30	28.24	59.08	12.17	.00
M12-05-28-BL	2.73	97.11	.10	.06	.82	.75	.84	8.64	51.18	31.17	5.05	1.07
M12-05-28-G	5.56	94.17	.20	.08	.62	.62	.97	17.04	44.45	27.97	3.86	.84
M12-05-28-H	2.17	97.71	.08	.04	.90	.85	.73	3.81	51.59	37.62	4.10	.59
M12-05-28-I	4.39	95.45	.10	.06	.81	.76	.81	3.63	55.26	31.31	4.68	.57
M12-05-29-BL	12.60	85.45	1.15	.80	1.95	2.24	1.61	.09	.43	25.80	46.31	12.82
M12-05-29-G	15.71	82.33	1.26	.70	1.74	2.02	1.69	.33	.00	33.35	37.21	11.45
M12-05-29-H	5.62	90.24	2.68	1.46	2.36	2.38	1.53	.27	.54	24.01	51.16	14.26
M12-05-29-I	14.44	83.80	1.13	.63	1.93	2.32	1.64	.00	.59	17.77	53.96	11.48
M12-06-00-BL	1.75	95.13	2.12	1.00	2.46	2.41	1.17	.00	.00	26.92	52.51	15.69
M12-07A-00-BL	.00	78.02	15.99	5.99	4.05	3.56	1.64	.00	.23	.00	13.97	63.82
M12-08-00-BL	.00	97.50	1.68	.82	1.69	1.56	1.15	.58	22.82	47.87	23.11	3.12
M12-09-00-BL	.00	97.34	1.82	.83	2.52	2.42	1.03	.00	.00	32.51	41.96	22.87
M12-10-00-BL	.00	99.54	.23	.22	2.04	2.03	.61	.00	1.00	47.68	49.57	1.29
M12-11-00-BL	.00	97.88	1.20	.92	3.00	2.85	.83	.00	.00	.69	57.74	39.45
M12-12-00-BL	.12	96.55	2.42	.91	1.48	1.29	1.25	.29	38.33	39.10	17.57	1.36
M12-13A-00-BL	.00	7.78	66.90	25.32	6.90	6.93	1.64	.00	.00	.00	.00	7.78
M12-13A-00-G	.00	8.91	68.32	22.77	6.76	6.80	1.63	.00	.00	.00	.00	8.91
M12-13A-00-H	.00	6.87	71.33	21.80	6.70	6.70	1.66	.00	.00	.00	.00	6.87
M12-13A-00-I	.00	7.18	69.09	23.73	6.85	6.88	1.59	.00	.00	.00	.00	7.18
M12-13-00-BL	.00	56.21	33.29	10.50	4.99	3.88	1.99	.00	.00	.00	3.32	52.89
M12-16-00-BL	4.09	94.86	.65	.39	.65	.57	1.21	26.47	34.34	26.18	7.02	.86
M12-16-00-G	2.55	96.00	.99	.46	.66	.52	1.21	25.34	42.34	20.45	7.87	.00
M12-16-00-H	2.38	95.24	1.61	.77	.94	.75	1.34	14.67	44.00	26.00	1 .00	.57
M12-16-00-I	2.34	96.96	.46	.25	.85	.80	1.07	16.77	38.50	32.09	9.02	.58
M12-17-00-BL	.52	98.91	.39	.17	1.23	1.18	.80	.30	40.95	45.99	10.79	.89
M12-17-00-G	.00	99.88	.08	.04	1.49	1.47	.68	.00	24.07	55.33	18.48	2.00
M12-17-00-H	.79	98.38	.60	.24	1.28	1.26	.86	.59	35.32	51.15	10.43	.89
M12-17-00-I	1.74	97.61	.47	.18	1.31	1.27	.92	.00	36.70	42.56	17.18	1.17
M12-18-00-BL	1.03	97.93	.62	.42	2.04	2.04	.81	.00	.88	45.94	50.53	.59
M12-18-00-G	1.30	97.87	.54	.28	2.05	2.07	.77	.00	.00	44.83	51.77	1.28
M12-18-00-H	.12	99.26	.39	.24	2.08	2.09	.62	.00	.00	45.26	53.50	.49
M12-18-00-I	.29	98.95	.50	.26	2.15	2.20	.67	.00	.99	36.42	60.55	.99

Appendix table 3B. - Textural analyses of samples from depth intervals of cores and grabs.

Sample	Sediment depth (cm)	>60μm (%)	<60μm (%)
M12-05-01-HX	0-2	0.93	99.07
	2-4	.83	99.17
	4-6	.77	99.23
	6-8	1.13	98.87
	8-10	1.27	98.73
	10-12	.90	99.10
	12-14	.76	99.24
	14-16	.60	99.40
M12-19-00-HX	0-2	5.01	94.99
	2-4	4.72	95.28
	4-6	4.95	95.05
	6-8	4.55	95.45
	8-10	4.48	95.52
	10-12	5.21	94.79
	12-14	5.84	94.16
M12-20-00-GX	0-2	1.48	98.52
	2-4	1.49	98.51
	4-6	2.30	97.70
	6-8	2.19	97.81
	8-10	1.72	98.28
M12-21-00-IX	0-2	2.04	97.96
	2-4	1.67	98.33
	4-6	1.62	98.38
	6-8	1.65	98.35
	8-10	1.70	98.30
	10-12	1.59	98.41
M12-16-00IX	0-2	0.72	99.28
	2-4	0.68	99.32
	4-6	0.78	99.22
	6-8	0.74	99.26
	8-10	0.91	99.09
	10-12	1.59	98.41

Appendix table 3C. - Textural analyses of samples from sediment traps

Sediment trap sample	Sediment depth (cm)	>60μm (%)	<60μm (%)
ST001	0-8	40	60
ST103	18-23	81	19
ST222	15-20	60	40
ST301	2-8	75	25
ST403	0-3	37	63
ST424	0-4	69	31
ST536	2-4	67	33
ST537	1/4 split	71	29

Appendix table 4A. - Chemical analyses of station blends and individual samples.

[Values accurate to two significant figures]

Field no.	Lab no.	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Hg (ppm)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)	Cl (%)
M09-01-00-BL	W-223657	0.86	130	<0.020	6.5	<1.0	0.45	--	86	<2.0	4.8	4.5	5.8	--
M09-02-00-BL	W-223658	.24	24	<.020	2.0	<1.0	.12	--	78	<2.0	1.9	<2.0	3.7	--
M09-02-00-G	W-223675	.23	23	<.020	<2.0	<1.0	.11	--	73	<2.0	1.7	<2.0	2.9	--
M09-02-00-H	W-223676	.23	24	<.020	<2.0	1.7	.10	--	83	<2.0	1.7	<2.0	2.9	--
M09-02-00-I	W-223677	.26	22	<.020	4.0	<1.0	.14	--	91	<2.0	2.3	<2.0	2.9	--
M09-03-00-BL	W-223659	.67	76	<.020	5.0	1.6	.34	--	160	<2.0	7.5	6.0	7.5	--
M09-04-00-BL	W-223660	1.10	170	<.020	11.0	1.1	.53	--	110	<2.0	6.2	10.0	9.1	--
M09-04-00-G	W-223678	1.10	160	<.020	13.0	1.0	.54	--	130	<2.0	6.2	15.0	9.5	--
M09-04-00-H	W-223679	1.10	170	<.020	10.0	<1.0	.54	--	81	<2.0	6.9	7.0	7.5	--
M09-04-00-I	W-223680	1.10	170	<.020	13.0	<1.0	.55	--	96	<2.0	5.8	10.0	8.3	--
M09-05-01-BL	W-223661	.23	52	<.020	5.0	<1.0	.41	--	350	<2.0	5.2	10.0	4.6	--
M09-05-01-G	W-223693	.23	69	<.020	5.5	<1.0	.42	--	380	<2.0	5.4	10.0	5.0	--
M09-05-01-H	W-223694	.23	51	<.020	5.0	<1.0	.38	--	320	<2.0	5.4	10.0	4.2	--
M09-05-01-I	W-223695	.21	40	.029	5.0	<1.0	.39	--	320	<2.0	5.6	8.5	4.2	--
M09-05-02-BL	W-223687	.22	42	<.020	4.0	<1.0	.36	--	230	<2.0	4.2	12.0	5.0	--
M09-05-03-BL	W-223590	--	50	--	--	--	.35	--	--	--	--	--	.2	--
M09-05-04-BL	W-223591	.21	33	--	--	--	.36	--	--	--	--	--	--	--
M09-05-05-BL	W-223592	.21	43	--	--	--	.36	--	--	--	--	--	--	--
M09-05-06-BL	W-223593	.19	34	--	--	--	.36	--	--	--	--	--	--	--
M09-05-07-BL	W-223594	.18	29	--	--	--	.29	--	--	--	--	--	--	--
M09-05-08-BL	W-223595	.26	44	--	--	--	.36	--	--	--	--	--	--	--
M09-05-09-BL	W-223596	.25	43	--	--	--	.39	--	--	--	--	--	--	--
M09-05-10-BL	W-223597	.22	40	--	--	--	.38	--	--	--	--	--	--	--
M09-05-11-BL	W-223598	.18	30	--	--	--	.40	--	--	--	--	--	--	--
M09-05-12-BL	W-223599	.25	45	--	--	--	.29	--	--	--	--	--	--	--
M09-05-13-BL	W-223600	.23	41	--	--	--	.34	--	--	--	--	--	--	--
M09-05-14-BL	W-223601	.18	30	--	--	--	.37	--	--	--	--	--	--	--
M09-05-15-BL	W-223602	.22	33	--	--	--	.26	--	--	--	--	--	--	--
M09-05-16-BL	W-223688	.26	43	.033	3.3	<1.0	.27	--	190	<2.0	4.6	7.0	2.9	--
M09-05-17-BL	W-223603	.25	39	--	--	--	.41	--	--	--	--	--	--	--
M09-05-18-BL	W-223689	.24	40	<.020	6.0	<1.0	.38	--	350	<2.0	5.0	8.5	4.6	--
M09-05-19-BL	W-223604	.23	45	--	--	--	.40	--	--	--	--	--	--	--
M09-05-20-BL	W-223690	.19	35	<.020	4.0	<1.0	.37	--	280	<2.0	3.7	8.5	4.6	--
M09-05-21-BL	W-223605	.15	25	--	--	--	.27	--	--	--	--	--	--	--
M09-05-22-BL	W-223606	.18	32	--	--	--	.32	--	--	--	--	--	--	--
M09-05-23-BL	W-223607	.21	35	--	--	--	.28	--	--	--	--	--	--	--
M09-05-24-BL	W-223608	.28	47	--	--	--	.32	--	--	--	--	--	--	--
M09-05-25-BL	W-223609	.25	41	--	--	--	.38	--	--	--	--	--	--	--
M09-05-26-BL	W-223610	.28	51	--	--	--	.38	--	--	--	--	--	--	--
M09-05-27-BL	W-223611	.19	37	--	--	--	.35	--	--	--	--	--	--	--
M09-05-28-BL	W-223691	.19	27	<.020	3.3	<1.0	.23	--	140	<2.0	2.9	5.0	2.1	--
M09-05-29-BL	W-223692	.85	128	<.020	13.0	1.5	.77	--	160	<2.0	7.5	18.0	9.5	--
M09-06-00-BL	W-223662	.93	130	<.020	13.0	1.9	.51	--	130	<2.0	8.5	13.0	10.0	--
M09-07-A0-BL	W-223663	2.60	250	.055	37.0	6.5	1.40	.03	220	12.0	17.0	53.0	30.0	--
M09-08-00-BL	W-223664	.40	28	<.020	7.0	1.0	.55	--	100	<2.0	4.6	4.5	10.0	--
M09-09-00-BL	W-223665	.95	87	<.020	14.0	1.4	.62	--	200	<2.0	6.6	13.0	12.0	--
M09-10-00-BL	W-223666	.94	79	.024	6.0	<1.0	.34	--	190	<2.0	5.0	5.0	7.5	--
M09-11-00-BL	W-223667	1.30	200	<.020	20.0	2.7	.81	--	140	<2.0	9.1	20.0	12.0	--
M09-12-00-BL	W-223668	.80	58	<.020	15.0	1.7	.75	--	180	<2.0	7.9	10.0	13.0	--
M09-13-00-BL	W-223670	3.30	250	.070	40.0	6.6	1.60	.03	280	16.0	21.0	63.0	39.0	--
M09-13-A0-BL	W-223669	5.00	270	.065	59.0	11.0	2.50	.04	300	31.0	27.0	82.0	60.0	--
M09-13-A0-G	W-223681	5.20	280	.081	58.0	10.0	2.70	--	300	32.0	26.0	80.0	60.0	--
M09-13-A0-H	W-223682	5.00	280	.086	59.0	11.0	2.50	--	300	32.0	29.0	82.0	60.0	--
M09-13-A0-I	W-223683	5.10	270	.053	61.0	9.9	2.50	--	300	32.0	25.0	77.0	59.0	--
M09-14-A0-BL	W-223671	5.20	290	.054	68.0	16.0	2.80	--	400	40.0	28.0	95.0	71.0	--
M09-16-00-BL	W-223672	.31	65	<.020	<2.0	<1.0	.17	--	130	<2.0	4.6	2.0	5.4	--
M09-16-00-G	W-223684	.32	77	<.020	<2.0	<1.0	.17	--	170	<2.0	5.0	2.0	6.2	--
M09-16-00-H	W-223685	.32	60	<.020	<2.0	<1.0	.16	--	120	<2.0	4.8	3.5	5.8	--
M09-16-00-I	W-223686	.30	96	<.020	<2.0	<1.0	.16	--	90	<2.0	4.8	2.0	5.4	--
M09-17-00-BL	W-223673	.23	15	<.020	<2.0	<1.0	.10	--	76	<2.0	2.1	<2.0	4.2	--

Appendix table 4A. - Chemical analyses of station blends and individual samples--Continued

[Values accurate to two significant figures]

Field no.	Lab no.	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Hg (ppm)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)	Cl (%)
M09-18-00-BL	W-223674	0.30	34	<0.020	3.0	<1.0	0.16	--	68	<2.0	5.6	2.0	5.8	--
M10-01-00-BL	W-224791	.86	140	<.020	7.0	<1.0	.47	--	92	<2.0	3.9	6.5	6.6	--
M10-02-00-BL	W-224792	.24	36	<.020	<2.0	<1.0	.09	--	56	<2.0	2.1	3.0	2.9	--
M10-02-00-G	W-224793	.27	38	<.020	<2.0	<1.0	.12	--	73	<2.0	2.1	3.0	2.9	--
M10-02-00-H	W-224794	.23	32	<.020	<2.0	<1.0	.10	--	56	<2.0	1.7	2.0	2.9	--
M10-02-00-I	W-224795	.23	35	<.020	<2.0	<1.0	.08	--	64	<2.0	1.7	2.0	2.5	--
M10-03-00-BL	W-224812	.77	90	<.020	8.0	1.5	.40	--	160	<2.0	7.1	7.0	8.3	--
M10-04-00-BL	W-224796	1.10	180	<.020	12.0	<1.0	.63	--	150	<2.0	5.6	14.0	9.1	--
M10-04-00-G	W-224797	1.10	180	<.020	11.0	<1.0	.56	--	120	<2.0	5.4	11.0	8.3	--
M10-04-00-H	W-224798	1.10	180	<.020	12.0	<1.0	.62	--	140	<2.0	5.6	12.0	9.1	--
M10-04-00-I	W-224799	1.20	170	<.020	16.0	1.1	.67	--	180	<2.0	5.6	14.0	11.0	--
M10-05-01-BL	W-224800	.27	63	.046	6.5	<1.0	.46	--	290	<2.0	4.6	12.0	7.1	--
M10-05-01-G	W-224801	.29	62	<.020	7.0	<1.0	.49	--	290	<2.0	4.4	14.0	7.1	--
M10-05-01-H	W-224802	.26	60	.025	5.5	<1.0	.43	--	280	<2.0	4.8	12.0	6.6	--
M10-05-01-I	W-224803	.28	68	<.020	7.0	<1.0	.43	--	260	<2.0	4.4	12.0	6.6	--
M10-05-02-BL	W-224823	.22	38	<.020	5.0	<1.0	.44	--	380	<2.0	4.2	15.0	5.8	--
M10-05-03-BL	W-224779	--	44	--	--	--	--	--	--	--	--	--	--	--
M10-05-04-BL	W-224780	--	38	--	--	--	--	--	--	--	--	--	--	--
M10-05-05-BL	W-224781	--	40	--	--	--	--	--	--	--	--	--	--	--
M10-05-06-BL	W-224782	--	35	--	--	--	--	--	--	--	--	--	--	--
M10-05-08-BL	W-224783	--	45	--	--	--	--	--	--	--	--	--	--	--
M10-05-09-BL	W-224784	--	41	--	--	--	--	--	--	--	--	--	--	--
M10-05-10-BL	W-224785	--	39	--	--	--	--	--	--	--	--	--	--	--
M10-05-11-BL	W-224786	--	44	--	--	--	--	--	--	--	--	--	--	--
M10-05-12-BL	W-224787	--	38	--	--	--	--	--	--	--	--	--	--	--
M10-05-14-BL	W-224788	--	32	--	--	--	--	--	--	--	--	--	--	--
M10-05-16-BL	W-224824	.25	35	<.020	4.0	<1.0	.31	--	140	<2.0	3.6	11.0	4.6	--
M10-05-18-BL	W-224825	.26	43	<.020	8.0	<1.0	.43	--	290	<2.0	4.4	15.0	4.6	--
M10-05-20-BL	W-224826	.22	40	.056	6.5	<1.0	.40	--	270	<2.0	4.0	13.0	4.6	--
M10-05-22-BL	W-224789	--	30	--	--	--	--	--	--	--	--	--	--	--
M10-05-25-BL	W-224790	--	40	--	--	--	--	--	--	--	--	--	--	--
M10-05-28-BL	W-224827	.18	26	<.020	2.5	<1.0	.23	--	130	<2.0	2.7	7.0	2.5	--
M10-05-29-BL	W-224828	.80	120	<.020	15.0	<1.0	.75	--	150	<2.0	7.7	16.0	8.7	--
M10-06-00-BL	W-224813	.94	130	<.020	13.0	1.8	.51	--	130	<2.0	6.6	15.0	10.0	--
M10-08-00-BL	W-224815	.49	49	<.020	8.5	<1.0	.63	--	110	<2.0	3.7	8.0	8.7	--
M10-09-00-BL	W-224816	1.00	100	<.020	17.0	3.1	.69	--	220	<2.0	6.2	15.0	12.0	--
M10-10-00-BL	W-224817	.84	80	<.020	5.5	<1.0	.29	--	130	<2.0	3.7	7.5	5.0	--
M10-11-00-BL	W-224818	1.60	240	<.020	18.0	1.7	.85	--	120	<2.0	8.3	22.0	12.0	--
M10-12-00-BL	W-224819	.73	67	<.020	13.0	<1.0	.71	--	160	<2.0	6.6	11.0	11.0	--
M10-13-00-BL	W-224820	3.10	270	.042	39.0	5.6	1.60	.02	290	14.0	21.0	59.0	35.0	--
M10-13-A0-BL	W-224804	4.60	280	.056	64.0	11.0	2.50	.04	300	33.0	27.0	84.0	58.0	--
M10-13-A0-G	W-224805	3.90	290	.046	58.0	11.0	2.40	--	300	33.0	26.0	87.0	57.0	--
M10-13-A0-H	W-224806	3.70	280	.054	62.0	11.0	2.40	--	290	33.0	27.0	87.0	58.0	--
M10-13-A0-I	W-224807	4.30	280	.046	65.0	11.0	2.40	--	300	33.0	27.0	92.0	58.0	--
M10-16-00-BL	W-224808	.32	190	<.020	2.5	<1.0	.16	--	80	<2.0	3.9	2.0	5.4	--
M10-16-00-G	W-224809	.33	430	<.020	2.5	<1.0	.17	--	70	<2.0	5.6	3.5	5.4	--
M10-16-00-H	W-224810	.28	99	<.020	<2.0	<1.0	.14	--	96	<2.0	3.7	2.0	4.6	--
M10-16-00-I	W-224811	.29	89	<.020	<2.0	<1.0	.13	--	63	<2.0	3.6	2.0	5.4	--
M10-17-00-BL	W-224821	.24	28	<.020	<2.0	<1.0	.09	--	57	<2.0	2.3	2.0	2.9	--
M10-18-00-BL	W-224822	.37	44	<.020	<2.0	<1.0	.17	--	84	<2.0	2.7	2.0	5.0	--
M10-7A-00-BL	W-224814	2.70	260	.033	36.0	5.6	1.40	.02	210	13.0	14.0	44.0	29.0	--
M11-01-00-BL	W-225598	.82	130	<.020	5.5	1.7	.39	--	68	<2.0	3.3	4.0	5.0	--
M11-01-00-BL	W-225548	.81	130	<.020	5.5	<1.0	.38	--	72	<2.0	3.7	5.5	4.2	--
M11-02-00-BL	W-225549	.25	40	<.020	<2.0	<1.0	.08	--	54	<2.0	1.4	<2.0	1.2	--
M11-02-00-G	W-225550	.24	40	<.020	<2.0	<1.0	.08	--	69	<2.0	1.5	<2.0	<1.0	--
M11-02-00-H	W-225551	.24	42	<.020	<2.0	<1.0	.08	--	51	<2.0	7.5	<2.0	2.1	--
M11-02-00-I	W-225552	.27	43	<.020	<2.0	<1.0	.10	--	66	<2.0	1.8	<2.0	1.3	--
M11-03-00-BL	W-225553	.74	95	<.020	4.0	1.5	.37	--	190	<2.0	6.9	4.5	6.6	--
M11-04-00-BL	W-225599	1.10	180	<.020	8.5	1.2	.52	--	86	<2.0	5.2	8.0	6.6	--
M11-04-00-BL	W-225554	1.20	180	<.020	10.0	<1.0	.51	--	87	<2.0	5.6	8.0	6.1	--

Appendix table 4A. - Chemical analyses of station blends and individual samples--Continued

[Values accurate to two significant figures]

Field no.	Lab no.	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Hg (ppm)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)	Cl (%)
M11-04-00-G	W-225555	1.10	180	<0.020	9.5	1.1	0.53	--	110	<2.0	5.6	7.5	7.5	--
M11-04-00-H	W-225556	1.10	190	<.020	9.5	<1.0	.51	--	79	<2.0	5.6	6.0	6.6	--
M11-04-00-I	W-225557	1.20	190	<.020	7.5	<1.0	.48	--	54	<2.0	5.4	6.0	5.4	--
M11-05-01-BL	W-225558	.28	180	<.020	5.5	<1.0	.44	--	330	<2.0	5.1	9.0	5.0	--
M11-05-01-G	W-225559	.33	130	<.020	5.5	<1.0	.43	--	300	<2.0	5.4	8.0	5.4	--
M11-05-01-H	W-225560	.26	86	<.020	5.0	<1.0	.44	--	310	<2.0	5.4	9.0	3.7	--
M11-05-01-I	W-225561	.25	110	<.020	5.0	<1.0	.46	--	320	<2.0	4.8	11.0	6.6	--
M11-05-02-BL	W-225580	.23	45	<.020	5.0	<1.0	.43	--	340	<2.0	4.2	13.0	4.6	--
M11-05-03-BL	W-225581	--	34	--	--	--	--	--	--	--	--	--	--	--
M11-05-04-BL	W-225582	--	36	--	--	--	--	--	--	--	--	--	--	--
M11-05-05-BL	W-225583	--	40	--	--	--	--	--	--	--	--	--	--	--
M11-05-06-BL	W-225584	--	35	--	--	--	--	--	--	--	--	--	--	--
M11-05-06-BL	W-225600	.22	34	<.020	4.0	<1.0	.41	--	330	<2.0	3.7	13.0	4.2	--
M11-05-08-BL	W-225585	--	46	--	--	--	--	--	--	--	--	--	--	--
M11-05-09-BL	W-225586	--	39	--	--	--	--	--	--	--	--	--	--	--
M11-05-10-BL	W-225587	--	38	--	--	--	--	--	--	--	--	--	--	--
M11-05-11-BL	W-225588	--	35	--	--	--	--	--	--	--	--	--	--	--
M11-05-12-BL	W-225589	--	47	--	--	--	--	--	--	--	--	--	--	--
M11-05-14-BL	W-225590	--	32	--	--	--	--	--	--	--	--	--	--	--
M11-05-16-BL	W-225591	.28	42	<.020	3.5	<1.0	.29	--	150	<2.0	3.7	4.0	3.6	--
M11-05-18-BL	W-225592	.25	40	.023	6.5	1.0	.43	--	320	<2.0	5.0	10.0	4.6	--
M11-05-20-BL	W-225593	.23	41	<.020	5.0	<1.0	.38	--	260	<2.0	4.0	8.0	4.6	--
M11-05-22-BL	W-225594	--	31	--	--	--	--	--	--	--	--	--	--	--
M11-05-25-BL	W-225595	--	51	--	--	--	--	--	--	--	--	--	--	--
M11-05-28-BL	W-225596	.20	27	<.020	2.0	<1.0	.22	--	180	<2.0	2.3	4.0	2.1	--
M11-05-29-BL	W-225597	.78	110	<.020	13.0	1.2	.78	--	160	<2.0	6.6	19.0	9.5	--
M11-06-00-BL	W-225562	.91	130	<.020	10.0	1.7	.50	--	130	<2.0	6.9	13.0	8.3	--
M11-07-A0-BL	W-225563	2.70	250	.058	33.0	5.6	1.40	--	210	11.0	15.0	46.0	26.0	--
M11-08-00-BL	W-225564	.49	54	<.020	5.5	<1.0	.62	--	110	<2.0	4.6	4.0	7.9	--
M11-09-00-BL	W-225565	.99	110	<.020	14.0	2.2	.62	--	180	<2.0	6.2	13.0	10.0	--
M11-10-00-BL	W-225566	.89	87	<.020	5.5	<1.0	.33	--	150	<2.0	4.0	6.5	4.6	--
M11-11-00-BL	W-225567	1.60	230	<.020	19.0	1.6	.85	--	130	2.0	8.1	20.0	11.0	--
M11-12-00-BL	W-225568	.80	73	<.020	12.0	1.4	.72	--	150	<2.0	6.9	11.0	10.0	--
M11-13-00-BL	W-225569	3.70	260	.090	38.0	6.1	1.60	--	270	13.0	18.0	60.0	33.0	--
M11-13-A0-BL	W-225570	4.90	290	.090	56.0	11.0	2.40	--	290	27.0	25.0	93.0	54.0	--
M11-13-A0-G	W-225571	5.00	280	.080	54.0	12.0	2.40	--	290	28.0	24.0	95.0	54.0	--
M11-13-A0-H	W-225572	5.00	280	.085	55.0	11.0	2.40	--	290	27.0	24.0	95.0	53.0	--
M11-13-A0-I	W-225573	5.00	280	.090	55.0	11.0	2.40	--	300	27.0	23.0	97.0	54.0	--
M11-16-00-BL	W-225574	.32	130	<.020	<2.0	<1.0	.18	--	110	<2.0	4.4	<2.0	4.7	--
M11-16-00-G	W-225575	.30	140	<.020	<2.0	<1.0	.15	--	110	<2.0	4.6	<2.0	3.7	--
M11-16-00-H	W-225576	.34	140	<.020	<2.0	2.6	.19	--	110	<2.0	5.0	<2.0	5.8	--
M11-16-00-I	W-225577	.35	180	<.020	<2.0	<1.0	.23	--	86	<2.0	6.9	<2.0	6.6	--
M11-17-00-BL	W-225578	.25	29	<.02	<2.0	<1.0	.13	--	84	<2.0	2.3	<2.0	2.1	--
M11-18-00-BL	W-225579	.32	47	<.02	<2.0	<1.0	.15	--	54	<2.0	3.1	<2.0	3.5	--
M12-01-00-BL	W-226794	.84	130	<.020	6.5	<1.0	.41	--	93	<2.0	3.3	3.0	5.8	--
M12-02-00-BL	W-226795	.26	35	<.020	<2.0	<1.0	.11	--	120	<2.0	1.7	<2.0	1.7	--
M12-02-00-G	W-226796	.27	40	<.020	<2.0	<1.0	.10	--	140	<2.0	1.7	<2.0	2.5	--
M12-02-00-H	W-226797	.26	35	<.020	<2.0	<1.0	.13	--	86	<2.0	1.9	<2.0	2.5	--
M12-02-00-I	W-226798	.27	36	<.020	<2.0	<1.0	.10	--	89	<2.0	1.7	<2.0	1.7	--
M12-03-00-BL	W-226799	.68	73	.027	5.0	1.1	.38	--	150	<2.0	3.7	5.5	7.5	--
M12-04-00-BL	W-226800	1.10	180	<.020	9.5	<1.0	.55	--	110	<2.0	5.0	10.0	7.5	--
M12-04-00-G	W-226801	1.20	180	<.020	13.0	<1.0	.65	--	150	<2.0	5.4	12.0	9.1	--
M12-04-00-H	W-226802	1.20	150	<.020	8.0	<1.0	.50	--	71	<2.0	6.2	5.5	5.8	--
M12-04-00-I	W-226803	1.20	180	.031	13.0	<1.0	.57	--	120	<2.0	5.2	10.0	7.5	--
M12-05-01-BL	W-226804	.22	36	<.020	4.5	<1.0	.42	--	320	<2.0	3.2	10.0	5.0	--
M12-05-01-G	W-226805	.25	39	<.020	5.0	<1.0	.45	--	320	<2.0	3.7	10.0	5.0	--
M12-05-01-H	W-226806	.23	37	<.020	5.0	<1.0	.44	--	260	<2.0	3.7	12.0	4.2	--
M12-05-01-I	W-226807	.21	37	<.020	4.0	<1.0	.42	--	410	<2.0	3.3	12.0	4.2	--
M12-05-02-BL	W-226826	.21	41	<.020	5.0	<1.0	.43	--	340	<2.0	3.6	13.0	5.0	--
M12-05-03-BL	W-226834	--	38	--	--	--	--	--	--	--	--	--	--	--

Appendix table 4A. - Chemical analyses of station blends and individual samples--Continued

[Values accurate to two significant figures]

Field no.	Lab no.	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Hg (ppm)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)	Cl (%)
M12-05-04-BL	W-226835	--	37	--	--	--	--	--	--	--	--	--	--	--
M12-05-05-BL	W-226836	--	42	--	--	--	--	--	--	--	--	--	--	--
M12-05-06-BL	W-226837	--	33	--	--	--	--	--	--	--	--	--	--	--
M12-05-07-BL	W-226838	--	32	--	--	--	--	--	--	--	--	--	--	--
M12-05-08-BL	W-226839	--	43	--	--	--	--	--	--	--	--	--	--	--
M12-05-09-BL	W-226840	--	43	--	--	--	--	--	--	--	--	--	--	--
M12-05-10-BL	W-226841	--	47	--	--	--	--	--	--	--	--	--	--	--
M12-05-11-BL	W-226842	--	40	--	--	--	--	--	--	--	--	--	--	--
M12-05-12-BL	W-226843	--	40	--	--	--	--	--	--	--	--	--	--	--
M12-05-13-BL	W-226844	--	43	--	--	--	--	--	--	--	--	--	--	--
M12-05-14-BL	W-226845	--	31	--	--	--	--	--	--	--	--	--	--	--
M12-05-15-BL	W-226846	--	33	--	--	--	--	--	--	--	--	--	--	--
M12-05-16-BL	W-226827	.26	36	<.020	4.0	<1.0	.29	--	190	<2.0	3.1	5.5	5.0	--
M12-05-17-BL	W-226847	--	40	--	--	--	--	--	--	--	--	--	--	--
M12-05-18-BL	W-226828	.24	40	<.020	6.5	1.2	.42	--	300	<2.0	4.0	12.0	5.0	--
M12-05-18-G	W-226848	--	39	--	--	--	--	--	--	--	--	--	--	--
M12-05-18-H	W-226849	--	43	--	--	--	--	--	--	--	--	--	--	--
M12-05-18-I	W-226850	--	40	--	--	--	--	--	--	--	--	--	--	--
M12-05-19-BL	W-226851	--	41	--	--	--	--	--	--	--	--	--	--	--
M12-05-20-BL	W-226829	.21	35	<.020	3.5	<1.0	.30	--	230	<2.0	3.1	8.5	3.3	--
M12-05-21-BL	W-226852	--	30	--	--	--	--	--	--	--	--	--	--	--
M12-05-22-BL	W-226853	--	32	--	--	--	--	--	--	--	--	--	--	--
M12-05-23-BL	W-226854	--	38	--	--	--	--	--	--	--	--	--	--	--
M12-05-24-BL	W-226855	--	53	--	--	--	--	--	--	--	--	--	--	--
M12-05-25-BL	W-226856	--	48	--	--	--	--	--	--	--	--	--	--	--
M12-05-26-BL	W-226857	--	49	--	--	--	--	--	--	--	--	--	--	--
M12-05-27-BL	W-226858	--	40	--	--	--	--	--	--	--	--	--	--	--
M12-05-28-BL	W-226830	.21	28	<.020	2.5	<1.0	.24	--	130	<2.0	2.3	3.0	2.5	--
M12-05-28-G	W-226859	--	33	--	--	--	--	--	--	--	--	--	--	--
M12-05-28-H	W-226860	--	31	--	--	--	--	--	--	--	--	--	--	--
M12-05-28-I	W-226861	--	34	--	--	--	--	--	--	--	--	--	--	--
M12-05-29-BL	W-226831	.84	120	<.020	9.5	1.0	.77	--	150	<2.0	4.6	20.0	9.1	--
M12-05-29-G	W-226862	--	120	--	--	--	--	--	--	--	--	--	--	--
M12-05-29-H	W-226863	--	130	--	--	--	--	--	--	--	--	--	--	--
M12-05-29-I	W-226864	--	120	--	--	--	--	--	--	--	--	--	--	--
M12-06-00-BL	W-226808	.90	110	<.020	14.0	<1.0	.47	--	140	<2.0	3.7	12.0	9.1	--
M12-07-A0-BL	W-226809	2.70	250	.073	32.0	4.2	1.40	--	220	8.4	11.0	30.0	27.0	--
M12-08-00-BL	W-226810	.45	45	<.020	5.0	<1.0	.56	--	110	<2.0	2.9	4.0	9.1	--
M12-09-00-BL	W-226811	1.10	110	<.020	14.0	<1.0	.63	--	190	<2.0	4.6	14.0	12.0	--
M12-10-00-BL	W-226812	1.00	87	.025	8.5	<1.0	.40	--	200	<2.0	3.7	6.0	7.1	--
M12-11-00-BL	W-226813	1.60	210	.025	16.0	1.7	.86	--	130	<2.0	7.5	18.0	12.0	--
M12-12-00-BL	W-226814	.71	57	<.020	8.5	2.1	.62	--	130	<2.0	7.9	6.0	11.0	--
M12-13-00-BL	W-226815	3.50	240	.063	35.0	4.3	1.60	--	280	10.0	15.0	52.0	38.0	--
M12-13-A0-BL	W-226816	4.00	300	.080	55.0	9.3	2.40	--	300	24.0	17.0	73.0	60.0	--
M12-13-A0-G	W-226817	3.80	300	.098	55.0	9.6	2.40	.01	300	24.0	16.0	73.0	60.0	--
M12-13-A0-H	W-226818	4.90	300	.091	67.0	10.0	2.50	--	310	26.0	19.0	86.0	60.0	--
M12-13-A0-I	W-226819	5.10	300	.071	55.0	11.0	2.50	--	320	27.0	20.0	75.0	61.0	--
M12-16-00-BL	W-226820	.38	73	<.020	2.5	<1.0	.21	--	160	<2.0	3.3	<2.0	5.8	--
M12-16-00-G	W-226821	.41	81	<.020	2.0	1.4	.23	--	300	<2.0	17.0	4.0	7.5	--
M12-16-00-H	W-226822	.34	84	<.020	<2.0	<1.0	.17	--	110	<2.0	3.7	<2.0	4.2	--
M12-16-00-I	W-226823	.34	56	<.020	<2.0	1.2	.19	--	86	<2.0	22.0	<2.0	24.0	--
M12-17-00-BL	W-226824	.25	29	<.020	<2.0	<1.0	.11	--	67	<2.0	1.5	<2.0	2.5	--
M12-17-00-G	W-226865	--	29	--	--	--	--	--	--	--	--	--	--	--
M12-17-00-H	W-226866	--	39	--	--	--	--	--	--	--	--	--	--	--
M12-17-00-I	W-226867	--	34	--	--	--	--	--	--	--	--	--	--	--
M12-18-00-BL	W-226825	.33	45	<.020	2.5	<1.0	.17	--	95	<2.0	2.7	<2.0	5.0	--
M12-18-00-G	W-226868	--	48	--	--	--	--	--	--	--	--	--	--	--
M12-18-00-H	W-226869	--	47	--	--	--	--	--	--	--	--	--	--	--
M12-18-00-I	W-226870	--	51	--	--	--	--	--	--	--	--	--	--	--

Appendix table 4B. - Chemical analyses of fine fraction (less than 60 μm) from station blends and individual samples.

[Values are accurate to two significant figures]

Field no.	Lab no.	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Hg (ppm)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)	Cl (%)
M01-09-00-BLX	W-223638	--	271	--	--	--	--	--	--	--	--	--	--	13.0
M01-10-00-BLX	W-223639	--	94	--	--	--	--	.10	--	--	--	--	--	40.0
M01-11-00-BLX	W-223640	--	209	--	--	--	--	.06	--	--	--	--	--	19.1
M01-16-00-BLX	W-223567	--	217	--	39.0	--	--	.47	--	--	--	--	--	27.0
M02-09-00-BLX	W-223641	--	240	--	--	--	--	--	--	--	--	--	--	18.0
M02-10-00-BLX	W-223642	--	44	--	--	--	--	<.10	--	--	--	--	--	44.0
M02-11-00-BLX	W-223643	--	214	--	--	--	--	.09	--	--	--	--	--	31.3
M02-16-00-BLX	W-223568	--	909	--	35.7	--	--	.41	--	--	--	--	--	24.3
M03-09-00-BLX	W-223644	--	278	--	--	--	--	--	--	--	--	--	--	18.1
M03-10-00-BLX	W-223645	--	144	--	--	--	--	.08	--	--	--	--	--	30.3
M03-11-00-BLX	W-223646	--	239	--	--	--	--	.07	--	--	--	--	--	19.5
M03-16-00-BLX	W-223569	--	5236	--	58.0	--	--	.49	--	--	--	--	--	24.8
M04-09-00-BLX	W-223647	--	316	--	--	--	--	--	--	--	--	--	--	19.3
M04-10-00-BLX	W-223648	--	27	--	--	--	--	.17	--	--	--	--	--	41.1
M04-11-00-BLX	W-223649	--	215	--	--	--	--	.05	--	--	--	--	--	13.4
M04-16-00-BLX	W-223570	--	5579	--	40.4	--	--	.47	--	--	--	--	--	23.8
M05-10-00-BLX	W-223650	--	72	--	--	--	--	.05	--	--	--	--	--	37.7
M05-11-00-BLX	W-223651	--	286	--	--	--	--	.06	--	--	--	--	--	17.8
M05-16-00-BLX	W-223571	--	7731	--	32.9	--	--	.35	--	--	--	--	--	21.7
M06-10-00-BLX	W-223652	--	68	--	--	--	--	--	--	--	--	--	--	36.5
M06-11-00-BLX	W-223653	--	120	--	--	--	--	.08	--	--	--	--	--	34.1
M06-16-00-BLX	W-223572	--	7101	--	46.9	--	--	.39	--	--	--	--	--	22.3
M07-10-00-BLX	W-223654	--	39	--	--	--	--	.06	--	--	--	--	--	36.7
M07-16-00-BLX	W-223573	--	7844	--	51.6	--	--	.31	--	--	--	--	--	33.9
M08-10-00-BLX	W-223655	--	22	--	--	--	--	.10	--	--	--	--	--	24.8
M08-11-00-BLX	W-223656	--	156	--	--	--	--	.07	--	--	--	--	--	36.6
M08-16-00-BLX	W-223574	--	3883	--	36.1	--	--	.38	--	--	--	--	--	24.7
M09-02-00-BLX	W-223696	1.23	<34	.749	10.2	22.5	.95	--	1601	<6.8	12.9	27.2	40.9	39.1
M09-02-00-GX	W-223723	1.17	36	.190	9.5	13.8	.86	--	1309	<4.8	17.9	23.8	30.9	32.1
M09-02-00-HX	W-223724	.48	<13	.144	3.9	15.7	.37	--	603	7.2	3.9	6.6	22.3	13.1
M09-02-00-IX	W-223725	2.70	<90	2.880	18.0	59.4	1.98	--	2790	18.0	50.4	36.0	74.7	49.2
M09-03-00-BLX	W-223697	3.81	183	.226	50.8	25.4	3.10	--	1410	39.5	47.9	95.9	86.0	16.1
M09-05-01-BLX	W-223706	3.23	1674	.222	48.4	22.2	2.82	--	4638	34.3	62.5	86.7	78.6	27.9
M09-05-01-GX	W-223711	3.19	2071	.223	51.0	20.7	2.55	--	3186	30.3	28.7	89.2	66.9	20.6
M09-05-01-HX	W-223712	2.66	1696	.205	43.0	18.4	2.25	--	3274	20.5	22.5	73.7	65.5	28.3
M09-05-01-IX	W-223713	2.36	1494	.260	33.0	21.2	2.34	--	6373	37.8	44.8	85.0	73.2	31.9
M09-05-02-BLX	W-223707	3.25	1137	.203	48.7	26.4	2.84	.13	3047	34.5	38.6	93.4	75.2	28.1
M09-05-03-BLX	W-223612	--	2009	--	--	--	--	--	--	--	--	--	--	23.2
M09-05-04-BLX	W-223613	--	678	--	--	--	--	--	--	--	--	--	--	31.2
M09-05-05-BLX	W-223614	--	1217	--	--	--	--	--	--	--	--	--	--	33.7
M09-05-06-BLX	W-223615	--	655	--	--	--	--	--	--	--	--	--	--	34.3
M09-05-07-BLX	W-223616	--	415	--	--	--	--	--	--	--	--	--	--	32.8
M09-05-08-BLX	W-223617	--	772	--	--	--	--	--	--	--	--	--	--	17.4
M09-05-09-BLX	W-223618	--	883	--	--	--	--	--	--	--	--	--	--	21.0
M09-05-10-BLX	W-223619	--	1045	--	--	--	--	--	--	--	--	--	--	25.7
M09-05-11-BLX	W-223620	--	461	--	--	--	--	--	--	--	--	--	--	37.7
M09-05-12-BLX	W-223621	--	605	--	--	--	--	--	--	--	--	--	--	34.3
M09-05-13-BLX	W-223622	--	593	--	--	--	--	--	--	--	--	--	--	32.3
M09-05-14-BLX	W-223623	--	424	--	--	--	--	--	--	--	--	--	--	28.6
M09-05-15-BLX	W-223624	--	422	--	--	--	--	--	--	--	--	--	--	35.3
M09-05-16-BLX	W-223625	--	494	--	--	--	--	--	--	--	--	--	--	35.2
M09-05-17-BLX	W-223626	--	559	--	--	--	--	--	--	--	--	--	--	22.1
M09-05-18-BLX	W-223708	3.00	420	.400	42.0	20.0	2.40	--	3603	32.0	30.0	68.1	64.1	27.7
M09-05-19-BLX	W-223627	--	1592	--	--	--	--	--	--	--	--	--	--	37.2

Appendix table 4B. - Chemical analyses of fine fraction (less than 60 μm) from station blends and individual samples—Continued

[Values are accurate to two significant figures]

Field no.	Lab no.	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Hg (ppm)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)	Cl (%)
M09-05-20-BLX	W-223628	--	894	--	--	--	--	--	--	--	--	--	--	34.8
M09-05-21-BLX	W-223629	--	387	--	--	--	--	--	--	--	--	--	--	33.9
M09-05-22-BLX	W-223630	--	236	--	--	--	--	--	--	--	--	--	--	22.5
M09-05-23-BLX	W-223631	--	265	--	--	--	--	--	--	--	--	--	--	26.1
M09-05-24-BLX	W-223632	--	678	--	--	--	--	--	--	--	--	--	--	28.9
M09-05-25-BLX	W-223633	--	488	--	--	--	--	--	--	--	--	--	--	29.6
M09-05-26-BLX	W-223634	--	765	--	--	--	--	--	--	--	--	--	--	19.6
M09-05-27-BLX	W-223635	--	928	--	--	--	--	--	--	--	--	--	--	34.9
M09-05-28-BLX	W-223709	1.65	136	.119	19.5	20.8	1.43	--	2383	18.4	26.0	45.5	45.5	29.8
M09-05-29-BLX	W-223710	3.43	483	.187	56.1	23.4	3.43	--	467	24.9	37.4	109.0	71.6	19.8
M09-08-00-BLX	W-223698	3.70	222	.277	46.2	22.2	2.59	--	998	29.6	48.1	70.2	77.6	25.4
M09-09-00-BLX	W-223699	4.59	262	.149	67.2	23.0	3.12	--	689	29.5	29.5	101.7	68.9	21.6
M09-10-00-BLX	W-223636	--	--	--	--	--	--	.22	--	--	--	--	--	44.4
M09-11-00-BLX	W-223637	--	265	--	--	--	--	--	--	--	--	--	--	24.6
M09-12-00-BLX	W-223700	4.49	237	.158	66.0	23.7	3.30	--	567	34.3	35.6	104.2	76.5	13.4
M09-13-00-BLX	W-223701	5.17	269	.140	64.7	12.9	2.80	--	420	24.8	46.3	107.8	65.8	4.0
M09-13-A0-BLX	W-223702	5.02	282	.066	62.7	12.5	2.72	--	335	27.2	35.5	90.9	61.7	2.4
M09-16-00-BLX	W-223703	3.76	4060	.416	49.5	25.7	2.57	--	1307	35.6	75.3	71.3	118.8	27.4
M09-16-00-GX	W-223714	4.56	4078	.937	60.8	27.9	3.04	--	1216	40.5	32.9	86.1	149.5	33.5
M09-16-00-HX	W-223715	3.13	2710	.173	41.7	27.1	2.08	.08	896	27.1	68.8	62.5	110.5	28.8
M09-16-00-IX	W-223716	3.60	4724	.220	46.0	28.0	2.60	--	981	32.0	46.0	76.1	102.1	27.7
M09-17-00-BLX	W-223704	3.13	256	.341	34.1	27.3	2.05	--	1195	14.2	39.8	59.8	65.5	35.9
M09-17-00-GX	W-223717	2.73	450	.139	33.6	25.2	1.89	--	924	17.9	31.5	50.4	56.7	29.0
M09-17-00-HX	W-223718	1.84	165	.168	18.9	22.7	1.23	--	519	4.7	9.9	28.3	47.2	31.9
M09-17-00-IX	W-223719	6.01	774	.398	57.9	44.1	3.83	--	1375	18.1	30.4	86.8	130.2	47.7
M09-18-00-BLX	W-223705	4.18	812	.487	51.1	27.8	2.78	--	766	37.1	32.5	78.9	97.5	31.5
M09-18-00-GX	W-223720	4.45	1212	.398	49.1	30.4	2.81	--	843	42.1	65.5	79.6	96.0	31.7
M09-18-00-HX	W-223721	3.54	1147	.149	42.5	28.3	2.60	--	732	23.6	22.7	66.1	82.6	31.9
M09-18-00-IX	W-223722	2.91	696	.058	36.8	23.3	1.78	--	330	36.8	69.8	40.7	67.9	26.8
M10-02-00-BLX	W-225193	1.31	89	.198	8.4	11.7	.92	--	1366	13.9	19.8	13.9	33.5	35.5
M10-02-00-GX	W-225194	2.42	154	.340	10.3	19.1	1.60	--	1184	10.3	32.4	15.4	51.5	44.6
M10-02-00-HX	W-225195	3.99	285	.525	<22.8	47.9	2.62	--	3195	<22.8	57.1	<22.8	94.7	50.5
M10-02-00-IX	W-225196	4.67	295	.582	32.8	54.1	3.03	--	3198	41.0	74.6	24.6	139.4	48.6
M10-03-00-BLX	W-225197	4.81	249	.432	58.1	36.5	3.15	--	664	53.1	99.6	89.6	107.9	22.0
M10-05-01-BLX	W-225215	3.68	2105	.211	52.6	26.3	2.63	--	2281	43.9	52.6	70.2	93.0	23.8
M10-05-01-GX	W-225216	3.79	3070	.181	54.2	25.3	2.89	--	2889	45.1	34.3	79.5	92.1	24.7
M10-05-01-HX	W-225217	3.87	3684	.085	55.3	22.1	2.58	--	2026	40.5	47.9	73.7	86.6	25.3
M10-05-01-IX	W-225218	3.65	2878	.710	57.6	23.0	2.88	--	2494	46.0	44.1	84.4	97.8	26.5
M10-05-02-BLX	W-225219	3.45	755	.119	47.5	28.1	2.59	--	3021	47.5	51.8	73.4	112.2	29.7
M10-05-04-BLX	W-225225	--	624	--	--	--	--	--	--	--	--	--	--	30.5
M10-05-14-BLX	W-225226	--	449	--	--	--	--	--	--	--	--	--	--	30.7
M10-05-16-BLX	W-225227	--	310	--	--	--	--	--	--	--	--	--	--	37.7
M10-05-18-BLX	W-225220	3.72	627	.157	50.9	31.3	2.94	--	2547	43.1	50.9	82.3	84.2	27.1
M10-05-20-BLX	W-225228	--	1087	--	--	--	--	--	--	--	--	--	--	22.8
M10-05-28-BLX	W-225221	2.46	319	.191	34.7	14.6	2.01	--	2776	34.7	52.1	38.2	59.0	39.4
M10-05-29-BLX	W-225222	3.48	504	.158	66.0	22.6	3.48	--	417	34.8	55.6	78.2	83.4	23.5
M10-08-00-BLX	W-225198	4.64	315	.278	64.9	33.4	3.15	--	872	48.2	66.8	77.9	92.7	25.5
M10-09-00-BLX	W-225199	4.86	271	.171	74.3	24.3	3.29	--	529	45.7	57.1	85.7	87.1	16.6
M10-10-00-BLX	W-225223	--	604	--	--	--	--	.28	--	--	--	--	--	49.3
M10-11-00-BLX	W-225224	--	266	--	--	--	--	.20	--	--	--	--	--	30.4
M10-12-00-BLX	W-225200	4.45	244	.119	60.3	23.0	3.02	--	431	37.3	60.3	86.1	80.4	16.8
M10-13-00-BLX	W-225201	5.20	287	.102	62.6	12.7	2.76	--	414	29.7	31.8	86.0	67.9	3.2
M10-13-A0-BLX	W-225202	5.20	291	.047	62.4	12.5	2.70	--	322	30.1	28.1	83.2	68.6	2.1
M10-16-00-BLX	W-225203	3.68	12105	.175	52.6	31.6	2.63	--	1158	40.4	66.7	56.1	159.6	23.8

Appendix table 4B. - Chemical analyses of fine fraction (less than 60 μm) from station blends and individual samples-Continued

[Values are accurate to two significant figures]

Field no	Lab no.	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Hg (ppm)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)	Cl (%)
M10-16-00-GX	W-225204	3.92	32408	.290	63.1	29.0	2.90	—	716	39.2	51.2	58.0	1142.8	22.9
M10-16-00-HX	W-225205	3.99	6981	.182	51.9	29.9	2.79	—	1516	43.9	83.8	69.8	131.6	27.6
M10-16-00-IX	W-225206	3.52	4966	1.014	45.5	29.0	2.28	—	869	35.2	70.4	53.8	153.1	28.6
M10-17-00-BLX	W-225207	3.37	562	.193	38.7	27.4	2.07	—	808	35.1	45.7	35.1	77.3	39.6
M10-17-00-GX	W-225208	2.41	1085	.232	31.4	24.1	1.47	—	265	69.9	36.2	26.5	60.3	32.4
M10-17-00-HX	W-225209	1.35	247	.450	<11.2	18.5	.96	—	1011	<11.2	25.8	<11.2	37.1	45.5
M10-17-00-IX	W-225210	3.56	398	.419	37.7	27.2	2.30	—	628	39.8	54.4	48.1	87.9	28.9
M10-18-00-BLX	W-225211	3.18	705	.273	34.1	31.8	2.02	—	977	31.8	59.1	36.4	84.1	31.0
M10-18-00-GX	W-225212	3.52	783	.356	35.6	30.6	2.31	—	1246	32.0	42.7	39.2	92.5	39.8
M10-18-00-HX	W-225213	1.75	220	.672	9.0	23.8	1.12	—	538	<9.0	24.6	<9.0	44.8	43.0
M10-18-00-IX	W-225214	3.31	814	.254	35.6	30.5	2.11	—	967	35.6	63.6	33.1	91.6	33.6
M11-02-00BLX	W-225854	4.22	271	.263	23.9	51.8	2.95	—	3584	41.4	70.1	<15.9	103.5	48.4
M11-02-00-GX	W-225855	2.43	173	.210	<9.3	37.4	1.68	—	2289	24.3	19.6	<9.3	56.1	43.5
M11-02-00-HX	W-225856	2.37	206	<.153	30.5	59.5	1.53	—	1451	15.3	9.9	<15.3	63.4	48.1
M11-02-00-IX	W-225857	4.20	326	.386	17.2	73.8	2.75	—	2403	34.3	36.0	17.2	103.0	48.9
M11-03-00-BLX	W-225858	4.63	248	.199	53.0	33.1	3.14	—	1076	53.0	51.3	102.6	99.3	21.9
M11-05-01-BLX	W-225859	4.38	4586	.138	56.3	31.3	3.34	—	2919	47.9	45.9	110.5	95.9	28.8
M11-05-01-GX	W-225860	5.45	4253	.165	65.4	29.1	3.82	—	2181	58.2	43.6	120.0	105.4	24.9
M11-05-01-HX	W-225861	8.25	6034	.326	95.5	52.1	6.08	—	5644	86.8	108.5	134.6	182.3	42.6
M11-05-01-IX	W-225862	4.08	5712	.299	49.0	24.5	2.99	—	2584	35.4	38.1	84.3	81.6	35.0
M11-05-01-IX	W-225891	3.56	5700	.168	53.4	22.9	2.80	—	2316	30.5	43.3	63.6	84.0	33.6
M11-05-02-BLX	W-225882	3.64	1668	.195	51.4	27.8	3.00	—	3854	45.0	49.2	85.6	98.5	29.5
M11-05-04-BLX	W-225883	—	754	—	—	—	—	—	—	—	—	—	—	34.8
M11-05-14-BLX	W-225884	—	690	—	—	—	—	—	—	—	—	—	—	40.1
M11-05-16-BLX	W-225885	—	1933	—	—	—	—	—	—	—	—	—	—	52.2
M11-05-18-BLX	W-225886	5.17	843	.272	76.2	38.1	4.08	—	4624	70.7	59.8	146.9	125.1	35.0
M11-05-28-BLX	W-225888	1.8	194	.160	20.3	15.8	2.3	—	1845	24.8	22.5	36.	50.	30.8*
M11-05-29-BLX	W-225889	4.37	529	.230	71.3	34.5	4.37	—	598	43.7	55.2	112.8	96.7	31.3
M11-08-00-BLX	W-225863	4.43	366	.193	53.9	32.7	3.08	—	1020	40.4	44.3	102.0	88.6	26.6
M11-09-00-BLX	W-225864	4.05	276	.081	61.6	21.1	2.76	—	616	29.2	22.7	123.2	68.1	21.2
M11-10-00-BLX	W-225865	—	250	—	—	—	—	—	—	—	—	—	—	
M11-11-00-BLX	W-225866	—	354	—	—	—	—	—	—	—	—	—	—	36.6
M11-12-00-BLX	W-225867	5.29	343	.156	84.1	29.6	3.58	—	607	49.8	46.7	186.8	98.1	19.8
M11-13-00-BLX	W-225868	5.55	316	.109	68.6	13.1	2.83	—	446	32.7	27.2	119.7	71.8	4.5
M11-13-00-BLX	W-225890	4.95	291	.076	66.7	12.9	2.69	—	431	33.4	31.2	99.0	71.0	3.9
M11-13-AO-BLX	W-225869	5.74	335	.071	62.8	13.0	2.81	—	357	31.4	28.1	108.2	71.4	4.2
M11-16-00-BLX	W-225870	3.83	5260	.200	49.9	33.3	2.83	—	1232	44.9	68.3	81.6	133.2	22.1
M11-16-00-GX	W-225871	5.11	10354	.192	69.0	38.3	3.83	—	2122	53.7	69.0	89.5	179.0	33.7
M11-16-00-HX	W-225872	8.33	10515	.451	104.1	59.0	5.55	—	2325	86.8	104.1	152.7	277.6	39.4
M11-16-00-IX	W-225873	4.04	7374	.231	52.0	28.9	3.08	—	1020	44.3	65.5	77.0	140.5	26.6
M11-17-00-BLX	W-225874	4.67	645	.372	44.7	69.5	3.08	—	1191	32.3	41.7	54.6	114.2	44.2
M11-17-00-GX	W-225875	2.38	334	.245	14.9	28.2	1.49	—	966	14.9	22.3	14.9	74.3	47.9
M11-17-00-HX	W-225876	3.12	369	.246	<16.4	90.2	2.05	—	1230	<16.4	47.6	<16.4	82.0	48.6
M11-17-00-IX	W-225877	3.28	401	.151	<38.3	21.9	2.01	—	365	<32.8	27.4	<51.1	67.5	25.0
M11-18-00-BLX	W-225878	4.48	1134	.272	53.7	41.8	2.98	—	895	41.8	59.7	59.7	113.4	36.8
M11-18-00-GX	W-225879	5.67	2018	.378	64.2	64.2	3.78	—	1058	52.9	90.7	75.6	143.6	40.7
M11-18-00-HX	W-225880	5.48	1173	.293	58.7	39.1	3.40	—	978	54.8	46.9	78.2	129.1	41.2
M11-18-00-IX	W-225881	3.66	931	.193	36.6	31.9	2.33	—	532	33.2	30.3	43.2	99.7	38.7
M12-02-00-BLX	W-226523	2.54	212	.917	<14.1	29.6	1.97	—	4442	42.3	40.9	28.2	148.1	47.5
M12-02-00-GX	W-226520	3.13	256	.519	25.0	30.0	2.50	—	6004	56.3	51.9	75.1	112.6	46.5
M12-02-00-HX	W-226521	1.76	196	.411	<19.6	17.6	1.47	—	4996	49.0	37.2	<19.6	64.7	49.7
M12-02-00-IX	W-226522	2.47	210	.562	<15.0	28.5	1.95	—	4719	44.9	37.4	<15.0	97.4	48.0*

*Estimated value, based on average Al value for this station.

Appendix table 4B. - Chemical analyses of fine fraction (less than 60 μm) from station blends and individual samples-Continued

[Values are accurate to two significant figures]

Field no	Lab no.	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Hg (ppm)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)	Cl (%)
M12-03-00-BLX	W-226524	4.92	254	.288	62.7	22.0	3.56	--	1068	57.6	72.9	130.5	132.2	22.7
M12-05-01-BLX	W-226525	4.28	947	.383	56.4	22.1	3.61	--	4960	58.6	54.1	108.2	115.0	30.8
M12-05-01-GX	W-226526	4.56	1096	.274	57.1	22.8	3.65	--	4565	59.3	57.1	118.7	125.5	31.1
M12-05-01-HX	W-226527	3.96	951	.238	53.5	19.4	3.37	--	3367	51.5	49.5	103.0	105.0	27.4
M12-05-01-IX	W-226528	3.55	765	.492	43.7	17.2	3.55	--	9020	68.3	60.1	101.1	123.0	35.1
M12-05-02-BLX	W-226529	3.51	1680	.468	53.8	23.4	3.74	.12	8659	70.2	60.8	112.3	86.6	31.7*
M12-05-03-BLX	W-226550	--	1070	--	--	--	--	--	--	--	--	--	--	35.7
M12-05-04-BLX	W-226551	--	711	--	--	--	--	--	--	--	--	--	--	28.1
M12-05-05-BLX	W-226552	--	514	--	--	--	--	--	--	--	--	--	--	29.5
M12-05-06-BLX	W-226553	--	762	--	--	--	--	--	--	--	--	--	--	40.1
M12-05-08-BLX	W-226555	--	568	--	--	--	--	--	--	--	--	--	--	23.2
M12-05-10-BLX	W-226557	--	962	--	--	--	--	--	--	--	--	--	--	26.0
M12-05-11-BLX	W-226558	--	429	--	--	--	--	--	--	--	--	--	--	24.4
M12-05-12-BLX	W-226559	--	566	--	--	--	--	--	--	--	--	--	--	35.8
M12-05-13-BLX	W-226560	--	507	--	--	--	--	--	--	--	--	--	--	33.5
M12-05-14-BLX	W-226561	--	401	--	--	--	--	--	--	--	--	--	--	38.8
M12-05-15-BLX	W-226562	--	477	--	--	--	--	--	--	--	--	--	--	39.1
M12-05-16-BLX	W-226563	--	399	--	--	--	--	--	--	--	--	--	--	30.4
M12-05-17-BLX	W-226564	--	601	--	--	--	--	--	--	--	--	--	--	36.0
M12-05-18-BLX	W-226530	3.82	531	.199	54.8	15.3	3.32	--	3651	46.5	48.1	99.6	99.6	22.0
M12-05-19-BLX	W-226565	--	901	--	--	--	--	--	--	--	--	--	--	35.7
M12-05-21-BLX	W-226567	--	235	--	--	--	--	--	--	--	--	--	--	33.2
M12-05-22-BLX	W-226568	--	254	--	--	--	--	--	--	--	--	--	--	27.0
M12-05-23-BLX	W-226569	--	317	--	--	--	--	--	--	--	--	--	--	25.7
M12-05-24-BLX	W-226570	--	153	--	--	--	--	--	--	--	--	--	--	35.4
M12-05-25-BLX	W-226571	--	384	--	--	--	--	--	--	--	--	--	--	20.8
M12-05-26-BLX	W-226572	--	715	--	--	--	--	--	--	--	--	--	--	27.5
M12-05-27-BLX	W-226573	--	280	--	--	--	--	--	--	--	--	--	--	40.5
M12-05-28-BLX	W-226531	1.09	133	.160	5.3	7.0	1.14	--	2982	26.3	19.3	24.6	42.1	23.8
M12-05-29-BLX	W-226532	6.58	687	.237	108.7	31.5	7.15	--	973	68.7	77.2	203.1	165.9	36.0
M12-08-00-BLX	W-226533	4.11	289	.183	57.9	19.8	3.05	--	959	45.7	48.7	79.2	100.5	19.0
M12-09-00-BLX	W-226534	7.50	432	.207	129.6	27.3	5.46	--	1159	75.0	54.6	186.4	159.1	31.0
M12-10-00-BLX	W-226574	--	74	--	--	--	--	.04	--	--	--	--	--	25.4
M12-11-00-BLX	W-226575	--	214	--	--	--	--	.10	--	--	--	--	--	21.7
M12-12-00-BLX	W-226535	4.58	270	.162	72.8	18.9	3.51	--	620	48.5	51.2	90.3	101.1	14.3
M12-13-00-BLX	W-226536	4.96	295	.096	61.1	11.6	2.85	.03	453	34.8	24.2	97.0	79.1	2.8
M12-13-A0-BLX	W-226537	6.81	464	.067	94.4	17.0	4.03	.05	511	51.1	27.9	128.5	114.6	19.6
M12-16-00-BLX	W-226541	4.09	2434	.162	53.3	23.1	3.20	.12	2310	53.3	53.3	85.3	177.7	24.2
M12-16-00-GX	W-226538	5.00	2482	.240	64.1	38.0	3.60	--	3803	66.1	74.1	120.1	200.2	27.7
M12-16-00-HX	W-226539	3.62	2700	.136	47.1	27.2	2.90	--	1468	50.7	48.9	79.7	141.3	24.8
M12-16-00-IX	W-226540	4.00	4264	.220	54.0	24.0	3.00	--	941	42.0	68.1	82.1	220.2	27.7*
M12-17-00-BLX	W-226545	4.87	514	.203	56.8	24.9	3.52	--	1218	62.3	48.7	67.7	135.3	34.9
M12-17-00-GX	W-226542	1.41	204	.236	<15.7	16.5	1.10	--	2355	<15.7	23.6	<15.7	51.8	48.3
M12-17-00-HX	W-226543	3.89	482	.139	48.2	22.3	2.78	--	909	51.9	33.4	68.6	103.8	25.5
M12-17-00-IX	W-226544	3.96	416	.198	45.5	21.8	2.77	--	951	77.2	39.6	59.4	101.0	27.4
M12-18-00-BLX	W-226549	5.10	849	.538	65.1	36.8	3.68	--	1982	65.1	65.1	87.8	150.1	35.8
M12-18-00-GX	W-226546	4.14	517	.786	53.8	24.8	2.90	--	414	55.9	33.1	84.8	120.0	28.6
M12-18-00-HX	W-226547	3.39	533	.220	60.6	22.3	2.66	--	3149	48.4	46.0	53.3	109.0	32.5
M12-18-00-IX	W-226548	4.42	1016	.183	55.2	28.7	3.31	--	1127	53.0	64.1	68.5	128.2	30.3

*Estimated value, based on average Al value for this station.

Appendix table 4C. - Chemical analyses of the following size fractions of bottom sediment: S0, undifferentiated; S1, >1,000 µm; S2, 1,000-5,000 µm; S3, 500-210 µm; S4, 210-105 µm; S5, 105-60 µm; S6, 60-30 µm; S7, 30-10 µm; S8, 10-1 µm; S9, <1 µm.

Field no.	Lab no.	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Hg (ppm)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)	Cl (%)
M04-02-00-S0	W-221284	0.27	55	<0.020L	<2.0	<1.0	0.11	0.01	110	<2.0	3.0	<2.0	3.3	—
M04-02-00-S0	W-221283	.27	65	<.020	<2.0	<1.0	.11	.01	110	<2.0	2.7	<2.0	2.9	—
M04-02-00-S0	W-221282	.27	83	<.020	<2.0	<1.0	.11	.01	110	<2.0	2.7	<2.0	5.0	—
M04-02-00-S1	W-219904	.32	51	<.020	3.3	<1.0	.27	—	300	4.9	4.0	10.0	4.6	—
M04-02-00-S2	W-219905	.16	32	<.020	<2.0	<1.0	.09	—	84	1.3	1.9	3.1	2.1	—
M04-02-00-S3	W-219906	.25	51	<.020	10.0	<1.0	.07	—	26	<1.0	2.7	<2.0	<2.0	—
M04-02-00-S4	W-219907	1.20	150	.033	24.0	<1.0	1.90	—	1400	8.3	13.0	16.0	23.0	—
M04-02-00-S5	W-219908	2.00	260	.260	49.0	4.6	2.30	—	3900	32.0	11.0	59.0	51.0	—
M04-02-00-S6	W-219893	1.90	280	8.200	38.0	13.0	1.80	—	1100	78.0	28.0	51.0	98.0	—
M04-02-00-S7	W-219894	3.00	240	1.600	36.0	45.0	2.90	—	8400	110.0	75.0	85.0	150.0	—
M04-02-00-S8	W-219895	3.00	480	3.700	98.0	240.0	3.00	—	7500	320.0	110.0	70.0	290.0	—
M04-02-00-S9	W-219896	.18	34	.190	3.3	5.0	.16	—	290	9.4	3.1	7.5	17.0	—
M04-05-02-S0	W-221272	.24	87	<.020	3.0	<1.0	.38	.01	250	<2.0	5.5	6.0	6.6	—
M04-05-02-S1	W-221273	.19	74	<.020	2.0	<1.0	.72	.01	310	<2.0	4.0	22.0	6.6	—
M04-05-02-S2	W-221274	.11	16	<.020	<2.0	<1.0	.35	.01	190	<2.0	4.0	5.0	4.6	—
M04-05-02-S3	W-221275	.23	43	<.020	2.2	<1.0	.28	<.01	180	<2.0	5.9	2.2	7.3	—
M04-05-02-S4	W-221276	1.30	230	<.020	24.0	1.7	1.10	.01	650	<2.0	14.0	30.0	20.0	—
M04-05-02-S5	W-221277	2.20	1000	.048	37.0	3.6	1.80	.01	1700	8.5	27.0	64.0	34.0	—
M04-05-02-S6	W-221278	3.50	11000	.290	55.0	20.0	3.20	.05	5000	34.0	66.0	100.0	100.0	—
M04-05-02-S7	W-221279	3.70	4000	.400	58.0	28.0	3.40	.08	4700	46.0	99.0	110.0	120.0	—
M04-05-02-S8	W-221280	3.60	3500	.460	69.0	130.0	3.40	—	4300	46.0	120.0	28.0	320.0	—
M04-05-02-S9	W-221281	.63	359	<.090	9.0	14.8	.54	.13	448	9.0	17.9	9.0	53.8	43.0
M04-16-00-S1	W-219897	.52	72	<.020	3.1	<1.0	.24	—	51	2.9	3.7	5.4	5.4	—
M04-16-00-S2	W-219898	.16	27	<.020	<2.0	<1.0	.06	—	<10	1.4	2.0	2.0	2.1	—
M04-16-00-S3	W-219899	.26	44	<.020	2.2	<1.0	.14	—	83	1.3	2.7	2.9	4.2	—
M04-16-00-S4	W-219900	1.00	280	<.020	33.0	2.0	2.20	—	1500	9.3	23.0	22.0	32.0	—
M04-16-00-S5	W-219909	2.40	4150	.610	34.0	5.3	1.60	—	400	17.0	16.0	34.0	67.0	—
M04-16-00-S6	W-219910	3.40	3730	.840	43.0	22.0	2.50	—	900	27.0	64.0	51.0	120.0	—
M04-16-00-S7	W-219911	3.90	1900	2.900	57.0	50.0	3.00	—	1100	79.0	120.0	49.0	250.0	—
M04-16-00-S8	W-219912	4.40	1200	2.600	62.0	56.0	3.40	—	1300	78.0	120.0	63.0	260.0	—
M04-16-00-S9	W-219913	1.60	250	.290	25.0	11.0	1.30	—	500	27.0	20.0	34.0	80.0	—
M10-02-00-S0	W-225966	.25	35	<.020	3.0	<1.0	.09	—	68	<2.0	1.5	<2.0	<2.0	—
M10-02-00-S1	W-225967	.28	36	<.020	2.0	<1.0	.25	—	230	2.0	1.1	5.5	5.0	—
M10-02-00-S2	W-225968	.15	20	.023	<2.0	<1.0	.07	—	45	<2.0	<1.0	<2.0	3.3	—
M10-02-00-S3	W-225969	.24	35	<.020	<2.0	<1.0	.07	—	41	<2.0	1.5	<2.0	2.5	—
M10-02-00-S4	W-225970	1.30	120	.029	49.0	1.8	2.30	—	1400	6.5	14.0	69.0	41.0	—
M10-02-00-S5	W-225971	2.50	330	.580	51.0	29.0	1.90	—	6000	78.0	23.0	53.0	94.0	—
M10-02-00-S6	W-225972	3.40	240	.300	45.0	38.0	2.20	—	3000	58.0	39.0	72.0	100.0	—
M10-02-00-S7	W-225973	2.90	180	.280	41.0	51.0	2.00	—	2000	50.0	38.0	60.0	120.0	—
M10-02-00-S8	W-225974	3.60	200	.500	52.0	100.0	2.60	—	2300	58.0	55.0	80.0	160.0	—
M10-02-00-S9	W-225975	1.91	153	.458	<25.4	84.0	1.25	—	1222	25.4	<12.7	50.9	152.7	51.0
M10-05-02-S0	W-225986	.21	51	<.020	7.5	<1.0	.39	—	330	<2.0	4.6	11.0	5.8	—
M10-05-02-S1	W-225987	.15	39	.160	6.0	<1.0	.61	—	300	<2.0	2.9	17.0	4.2	—
M10-05-02-S2	W-225988	.12	25	<.020	5.4	<1.0	.30	—	240	<2.0	3.4	7.1	4.2	—
M10-05-02-S3	W-225989	.29	50	.033	7.5	<1.0	.29	—	260	<2.0	4.2	5.0	5.0	—
M10-05-02-S4	W-225990	1.30	260	<.020	26.0	1.2	1.10	—	1500	4.0	14.0	17.0	23.0	—
M10-05-02-S5	W-225991	2.20	900	.025	44.0	4.2	1.90	—	2500	14.0	15.0	52.0	40.0	—
M10-05-02-S6	W-225992	2.80	2100	.180	50.0	12.0	2.40	—	5800	40.0	25.0	87.0	68.0	—
M10-05-02-S7	W-225993	4.40	1100	.320	66.0	48.0	4.00	—	6400	84.0	83.0	150.0	170.0	—
M10-05-02-S8	W-225994	4.40	1200	.480	79.0	52.0	4.40	—	6500	90.0	90.0	170.0	200.0	—
M10-05-02-S9	W-225995	2.44	332	.754	39.2	48.3	2.26	—	3318	36.2	60.3	87.5	132.7	37.0
M10-16-00-S0	W-225976	.29	69	<.020	6.0	<1.0	.14	—	72	<2.0	2.7	<2.0	6.6	—
M10-16-00-S1	W-225977	.82	66	.027	11.0	<1.0	.52	—	91	<2.0	2.7	8.5	13.0	—
M10-16-00-S2	W-225978	.19	22	<.02	3.0	<1.0	.08	—	47	<2.0	2.3	<2.0	2.5	—
M10-16-00-S3	W-225979	.20	29	<.02	2.0	<1.0	.08	—	62	<2.0	5.2	<2.0	4.2	—
M10-16-00-S4	W-225980	.76	240	<.02	22.0	<1.0	.75	—	490	<2.0	12.0	13.0	25.0	—
M10-16-00-S5	W-225981	2.30	6700	.041	35.0	4.6	1.60	—	380	8.5	25.0	32.0	58.0	—
M10-16-00-S6	W-225982	3.00	6700	.180	46.0	15.0	1.90	—	520	21.0	31.0	56.0	100.0	—
M10-16-00-S7	W-225983	4.50	6400	.240	66.0	37.0	3.00	—	1200	51.0	70.0	110.0	170.0	—
M10-16-00-S8	W-225984	4.80	3100	.440	77.0	53.0	3.40	—	1600	69.0	100.0	110.0	230.0	—
M10-16-00-S9	W-225985	4.58	2397	2.115	84.6	77.6	3.45	—	1974	49.4	84.6	148.1	338.4	47.5

Table 4D. - Chemical analysis of core samples and grab samples subsectioned in sequential depth intervals. Depth interval, in cm, is given at end of field number

Field no.	Lab no.	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Hg (ppm)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)	Cl (%)
M10-02-00-JX 00-02	W-225158	0.88	77	0.096	<4.2	13.2	0.77	—	1046	10.5	14.9	16.7	19.0	28.9
M10-02-00-JX 02-04	W-225159	1.27	95	.127	6.0	16.1	1.03	—	1270	13.1	15.1	20.2	30.2	27.9
M10-02-00-JX 06-08	W-225161	.87	93	.349	<5.8	27.0	.90	—	872	5.8	17.7	11.6	26.4	36.3
M10-02-00-JX 08-10	W-225162	.99	90	.134	<5.8	18.3	1.05	—	1191	8.7	18.3	23.2	32.0	36.3
M10-02-00-JX 10-12	W-225163	.84	81	.336	<5.6	12.6	.98	—	1009	8.4	17.7	16.8	25.5	35.6
M10-02-00-JX 12-14	W-225164	.97	77	.072	5.0	13.6	.94	—	867	7.4	16.3	17.3	27.2	33.0
M10-12-00-GX 00-02	W-225165	4.08	250	.109	52.7	23.7	3.29	—	461	40.8	63.2	92.1	76.3	13.3
M10-12-00-GX 02-04	W-225166	4.41	252	.164	56.7	27.7	3.40	—	441	45.3	81.9	108.3	83.1	11.4
M10-12-00-GX 04-06	W-225167	4.47	241	.181	60.4	27.8	3.38	—	386	47.1	84.5	111.1	83.3	9.5
M10-12-00-GX 06-08	W-225168	4.55	246	.197	62.7	28.3	3.44	—	356	47.9	89.7	117.9	88.5	10.3
M10-12-00-GX 08-10	W-225169	4.60	230	.266	61.7	30.2	3.39	—	315	48.4	82.3	118.6	90.7	9.6
M10-12-00-GX 10-12	W-225170	4.89	232	.245	67.3	30.6	3.55	—	306	48.9	80.7	134.6	91.7	10.1
M10-12-00-GX 12-14	W-225171	4.54	233	.356	63.7	28.2	3.43	—	294	49.0	74.8	134.9	85.8	10.2
M11-03-00-AX 00-02	W-226059	3.70	179	.281	57.5	28.1	2.30	—	281	40.9	66.4	127.7	93.2	12.0
M11-03-00-AX 02-04	W-226060	4.94	256	.366	76.8	42.1	3.48	—	878	58.6	91.5	162.8	118.9	25.1
M11-03-00-AX 04-06	W-226061	4.28	222	.443	64.9	30.1	2.69	—	428	50.7	82.4	158.4	96.6	20.4
M11-03-00-AX 06-08	W-226062	4.81	252	.229	91.6	29.8	3.43	—	332	44.6	44.6	160.2	92.7	7.0
M11-03-00-AX 08-10	W-226063	3.73	201	.316	58.9	38.8	2.30	—	273	43.1	79.0	132.1	93.3	16.8
M11-03-00-AX 10-12	W-226064	3.09	161	.334	50.7	22.3	1.98	—	346	34.6	64.3	110.1	77.9	10.6
M12-05-01-HX 00-02	W-226527	3.96	951	.238	53.5	19.4	3.37	—	3367	51.5	49.5	103.0	105.0	27.4
M12-05-01-HX 02-04	W-226507	3.49	894	.220	49.6	20.2	2.94	—	3488	40.4	45.9	88.1	84.4	25.2
M12-05-01-HX 04-06	W-226508	4.04	1542	.289	59.7	23.1	3.47	—	5968	57.8	77.0	121.3	105.9	26.6
M12-05-01-HX 06-08	W-226509	4.25	1226	.196	65.4	19.6	3.43	—	2943	54.0	44.1	114.5	98.1	21.5
M12-05-01-HX 08-10	W-226510	4.45	918	.191	65.1	22.2	3.34	—	1906	52.4	41.3	120.7	88.9	20.5
M12-05-01-HX 10-12	W-226511	4.77	844	.184	67.9	22.0	3.67	—	2019	56.9	47.7	119.3	97.3	25.2
M12-05-01-HX 12-14	W-226512	3.96	594	.234	57.6	23.4	3.06	—	1512	43.2	57.6	100.8	86.4	24.6
M12-05-01-HX 14-16	W-226513	4.11	596	.246	57.5	22.6	3.08	—	1992	45.2	49.3	98.6	94.5	28.4
M12-16-00-IX 00-02	W-226540	4.00	4264	.220	54.0	24.0	3.00	—	941	42.0	68.1	82.1	220.2	27.7
M12-16-00-IX 02-04	W-226514	4.28	7502	.196	61.2	30.6	2.85	—	754	42.8	108.0	89.7	326.2	28.2
M12-16-00-IX 04-06	W-226515	4.24	4948	.212	57.8	25.0	2.70	—	443	42.4	65.5	84.7	231.0	26.6
M12-16-00-IX 06-08	W-226516	4.60	5105	.300	64.1	32.0	2.80	—	380	52.0	70.1	112.1	200.2	27.7
M12-16-00-IX 08-10	W-226517	4.97	4253	.556	65.6	33.8	2.98	—	338	55.6	89.4	117.3	190.8	27.5
M12-16-00-IX 10-12	W-226518	4.76	2115	.343	64.8	28.6	2.67	—	343	53.3	104.8	133.4	162.0	26.3
M12-16-00-IX 12-14	W-226519	4.99	957	.339	63.8	33.9	2.79	—	359	55.8	67.8	125.7	131.6	27.6
M12-19-00-HX 00-02	W-226489	4.66	311	.092	77.7	12.9	3.11	.05	634	37.5	25.9	117.8	66.0	12.6
M12-19-00-HX 02-04	W-226490	5.44	321	.168	99.1	20.9	3.63	.06	628	44.7	37.7	153.6	93.5	15.7
M12-19-00-HX 04-06	W-226491	5.36	301	.196	88.9	19.6	3.53	.06	588	45.7	34.0	156.8	95.4	13.0
M12-19-00-HX 06-08	W-226492	5.43	310	.233	86.5	23.3	3.62	.06	620	49.1	36.2	155.0	94.3	12.5
M12-19-00-HX 08-10	W-226493	5.51	303	.234	102.0	23.4	3.72	.06	607	48.3	46.9	151.6	96.5	15.2
M12-19-00-HX 10-12	W-226494	6.01	323	.293	108.5	24.9	4.11	—	601	51.3	45.5	161.3	99.7	17.6
M12-19-00-HX 12-14	W-226495	5.42	304	.198	100.5	23.8	3.84	—	569	50.3	31.7	132.3	87.3	13.5
M12-20-00-GX 00-02	W-226496	4.29	395	.206	84.1	20.6	3.26	.08	566	39.5	41.2	108.1	87.5	23.1
M12-20-00-GX 02-04	W-226497	4.51	434	.234	80.1	20.0	3.51	.08	551	43.4	48.4	111.9	88.5	22.2
M12-20-00-GX 04-06	W-226498	4.24	396	.594	76.3	21.2	3.11	.07	410	42.4	65.0	118.8	84.8	16.2
M12-20-00-GX 06-08	W-226499	3.60	335	.199	67.1	17.4	2.61	.05	348	34.8	31.1	96.9	65.8	10.8
M12-20-00-GX 08-10	W-226500	4.55	396	.249	85.0	22.0	3.37	.06	513	44.0	49.9	114.4	89.4	17.6
M12-21-00-IX 00-02	W-226501	4.01	448	.148	74.1	18.5	3.24	.05	757	41.7	47.9	97.3	84.9	19.5

Table 4D. - Chemical analysis of core samples and grab samples subsectioned in sequential depth intervals. Depth interval, in cm, is given at end of field number-Continued

Field no.		Lab no.	Al (%)	Ba (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Hg (ppm)	Mn (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Zn (ppm)	Cl (%)
M12-21-00-IX	02-04	W-226502	4.32	479	.232	78.7	24.7	3.24	.06	463	41.7	49.4	120.4	86.5	19.5
M12-21-00-IX	04-06	W-226503	4.85	469	.291	95.3	27.5	3.56	.07	452	48.5	67.9	139.0	98.6	21.1
M12-21-00-IX	06-08	W-226504	4.75	428	.238	99.8	23.8	3.48	.07	443	47.5	47.5	136.2	88.7	20.4
M12-21-00-IX	08-10	W-226505	5.07	428	.253	87.1	23.8	3.64	.08	491	49.1	42.8	126.7	95.0	20.4
M12-21-00-IX	10-12	W-226506	5.24	456	.355	89.6	28.7	3.72	.07	541	50.7	57.5	148.7	106.5	22.6
OC140-39X	00-02	W-226045	4.20	234	.112	74.0	18.5	3.09	—	457	37.0	35.8	80.2	80.2	10.5
OC140-39X	02-04	W-226046	3.94	220	.139	73.0	18.5	2.89	—	394	37.1	30.1	89.2	78.7	7.6
OC140-39X	04-06	W-226047	4.10	211	.133	85.3	19.9	2.88	—	377	39.9	33.2	121.9	77.6	5.4
OC140-39X	06-08	W-226048	4.33	228	.182	80.9	20.5	3.08	—	433	39.9	28.5	148.1	83.1	6.8
OC140-39X	08-10	W-226049	4.75	244	.171	90.1	23.1	3.53	—	463	45.1	31.7	158.4	93.8	9.9
OC140-39X	10-12	W-226050	5.07	254	.254	105.2	22.8	3.93	—	469	50.7	20.3	177.5	95.1	11.7
OC140-39X	12-14	W-226051	4.68	234	.222	93.5	21.0	3.39	—	409	44.4	25.7	128.6	88.9	8.0
OC140-41X	00-02	W-226052	4.28	245	.196	79.5	23.2	3.06	—	367	36.7	31.8	134.6	80.7	10.1
OC140-41X	02-04	W-226053	4.41	255	.106	79.0	18.6	3.13	—	372	39.5	34.8	139.3	81.3	7.7
OC140-41X	04-06	W-226054	4.28	236	.191	75.4	19.1	2.93	--	326	36.0	33.8	123.8	76.5	6.2
OC140-41X	06-08	W-226055	4.81	259	.210	85.2	18.5	3.33	—	370	43.2	33.3	148.1	90.1	10.5
OC140-41X	08-10	W-226056	4.86	238	.283	82.6	24.9	3.39	—	328	45.2	44.1	147.0	96.1	6.4
OC140-41X	10-12	W-226057	5.79	362	.362	188.1	41.0	4.82	—	2267	60.3	132.6	164.0	135.1	32.4
OC140-41X	12-14	W-226058	5.08	236	.236	94.5	26.0	3.66	—	366	47.3	35.5	165.4	101.6	8.5
OC140-8BX	00-01	W-225172	5.35	299	.065	60.8	14.4	2.99	.05	360	31.9	33.0	88.6	70.0	1.6
OC140-8BX	01-02	W-225173	5.05	299	.134	56.6	15.4	2.99	.06	340	31.9	33.0	91.6	70.0	1.6
OC140-8BX	02-03	W-225174	4.92	287	.082	56.4	14.4	2.77	.07	339	33.9	32.8	89.3	69.8	1.4
OC140-8BX	03-04	W-225175	5.03	304	.209	62.8	16.8	2.72	.05	346	34.6	33.5	90.1	72.3	2.5
OC140-8BX	05-06	W-225176	4.64	299	.083	61.9	15.5	2.89	.06	330	35.1	27.9	88.7	71.2	1.7
OC140-8BX	07-08	W-225177	4.64	310	.073	56.7	15.5	2.79	.06	330	34.0	23.7	94.9	71.2	1.7
OC140-8BX	09-10	W-225178	4.54	299	.073	59.8	15.5	2.89	.06	330	37.1	25.8	88.7	71.2	1.7
OC140-8BX	11-12	W-225179	4.23	299	.060	61.9	16.5	2.79	.05	320	35.1	23.7	94.9	71.2	1.7
BULK SAMPLE PROFILE		83G-9 (BOX CORE)													
83G-9-B	00-01	W-225180	4.93	360	.063	51.4	21.6	2.98	.05	483	39.1	23.6	94.6	83.3	1.5
83G-9-B	01-02	W-225181	5.03	369	.065	51.3	21.5	3.08	.05	472	41.0	20.5	88.2	72.8	1.4
83G-9-B	02-03	W-225182	5.12	369	.073	52.2	21.5	3.17	.05	604	39.9	20.5	85.0	67.6	1.3
83G-9-B	03-04	W-225183	5.13	380	.043	55.4	18.5	3.18	.04	441	39.0	17.4	88.2	67.7	1.4
83G-9-B	04-05	W-225184	5.02	358	.088	54.3	19.5	3.07	.04	297	41.0	17.4	91.1	67.6	1.3
83G-9-B	05-07	W-225185	5.11	378	.143	58.3	24.5	3.07	.03	307	40.9	17.4	94.0	69.5	1.2
83G-9-B	07-09	W-225186	4.92	369	.113	56.3	17.4	2.87	.03	297	39.9	17.4	88.1	67.6	1.3
83G-9-B	09-11	W-225187	4.90	378	.173	52.0	18.4	2.86	.04	306	36.7	15.3	93.9	65.3	1.1
83G-9-B	11-13	W-225188	4.96	372	.103	52.7	18.6	2.89	.03	300	37.2	15.5	92.0	63.1	1.8
83G-9-B	15-17	W-225189	4.91	378	.098	54.2	19.4	2.86	.03	296	40.9	15.3	87.9	64.4	1.2
83G-9-B	17-19	W-225190	4.82	380	.088	52.3	14.4	2.87	.02	298	39.0	15.4	91.3	67.7	1.4
83G-9-B	23-25	W-225191	4.80	368	.102	52.1	19.4	2.86	.03	286	39.9	14.3	91.0	65.4	1.2
83G-9-B	25-31	W-225192	5.12	369	.088	56.3	11.3	3.17	.03	307	41.0	10.2	89.1	67.6	1.3